North Coast Watershed Assessment Program

DRAFT

Redwood Creek Watershed Synthesis Report

The mission of the North Coast Watershed Assessment Program is to conserve and improve California's north coast anadromous salmonid populations by conducting, in cooperation with public and private landowners, systematic multi-scale assessments of watershed conditions to determine factors affecting salmonid production and recommend measures for watershed improvements.

Public Review Draft

Analyses and Results

Redwood Creek and its Subbasins: Estuary, Prairie Creek, Lower Redwood Creek, Middle Redwood Creek, Upper Redwood Creek

Introduction

In this major section of this report, we present our analyses, findings, and recommendations for Redwood Creek.

For the purpose of the NCWAP study of Redwood Creek, the basin is divided into five subbasins. The five subbasins in Redwood Creek were designated based on geography, historical classification by Redwood National and State Park (RNSP), geology, climate patterns, land use, and conform with Calwater 2.2 Planning Watershed boundaries when possible. There are 22 planning watersheds as defined by the Calwater 2.2 system. Table 13 provides as summary of basic information about the five subbasins.

- The Estuary subbasin contains all the basin downstream of the confluence of Redwood and Prairie Creeks.

- The Prairie Creek subbasin is the only sub basin that is wholly a tributary to Redwood Creek. It is also the only subbasin that breaks a Calwater 2.2 Planning Watershed boundary. Ninety eight percent of the Prairie Creek subbasin is in public ownership.

- Lower Redwood Creek subbasin includes the area above the confluence of Redwood and Prairie Creeks to the confluence of Redwood and Devil's Creeks including Devil's Creek. This includes the area of the basin contained by Redwood National and State Park prior to the 1978 expansion with the exception of Park lands in Coyote Creek. The Lower Redwood Creek sub basin is 99.4% in Federal ownership.

- Middle Redwood Creek subbasin includes the area above the confluence of Redwood/Devil's Creeks excluding Devil's Creek up to the confluence of Redwood and Lupton Creeks including Lupton Creek. The Middle Redwood Creek subbasin includes the Park Protection Zone, Redwood Valley, and ends at the valley confinement upstream of State Highway 299 crossing. Geologically, this area has the greatest extent of the coherent unit of Lacks Creek on the upland Eastern side, but it also contains the greatest amount of the incoherent unit of Coyote Creek.

- Upper Redwood Creek subbasin is defined as the area above but not including Lupton Creek and covers the same area as the Calwater 2.2 Lake Prairie Hydrologic Area. This subbasin has the highest relief, greatest proportion of natural prairies and has the greatest percent of private ownership. Geologically, this subbasin has the greatest proportion of South Fork Mountain Schist, mélange units of Snow Camp

Mountain, and ultramafic Klamath Mountain rocks, yielding atypical soils and specialized vegetation.

Table 12: Redwood Creek Subbasin Summary.

	Estuary	Prairie Creek	Lower Redwood	Middle Redwood	Upper Redwood	Total
Square Miles	5.36	39.59	69.51	100.14	67.72	282.33
Acreage, Total	3,429	25,339	44,488	64,088	43,344	180,689
Private Acres	2,007	463	275	57,843	40,640	101,282
Federal Acres	1,422	18,247	44,212	5,838	2,240	71,960
State Acres	0	6,629	0	0	0	6,620
Principal Communities	Orick	Orick		Redwood Valley		
Predominant Land Use	Livestock Grazing	Park Land	Park Land	Timber Production	Timber Production	
Predominant Vegetation Type	Ag Land	Redwood Forest	Redwood Forest	Douglas-fir Forest	Hardwood Douglas-fir Forest	
Anadromous Fish accrss stream (mi.)	3.89	22.48	24.47	44.01	23.03	117.83
Low Elevation	0	26	26	325	866	0
High Elevation	1,243	2270	1,286	4,091	5,322	5,322
Fish Species	chinook coho steelhead coastal cutthroat trout pacific lamprey prickly sculpin starry flounder eulachon surf smelt night smelt	chinook coho steelhead coastal cutthroat trout rainbow trout sea lamprey pacific lamprey prickly sculpin coastrange sculpin 3 spine stickleback sucker	chinook coho steelhead coastal cutthroat trout rainbow trout pacific lamprey coastrange sculpin	chinook coho steelhead coastal cutthroat trout rainbow trout pacific lamprey	steelhead coastal cutthroat trout pacific lamprey chinook salmon	chinook coho steelhead coastal cutthroat trout rainbow trout sea lamprey pacific lamprey prickly sculpin coastrange sculpin 3 spine stickleback sucker

Redwood Creek Watershed Overview

While a number of impairments to salmonid habitat exist in the Redwood Creek watershed, recent studies have shown that parts of the upper one third of watershed is producing significant quantities of juvenile chinook salmon. Identified impairments include high instream sediment levels, stream channel aggradation and widening (level of the streambed rises and widens due to deposition of sediment and eroding streambanks), lack of stream habitat structure such as deep pools, stream water temperatures that are too high to support salmon, loss of functioning estuary habitat due to levee construction and excessive sediment accumulations. Human activities—such as road construction, grazing of livestock, timber management, and levee construction—have interacted with natural geologic instability and sediment production, and major rainstorm events (e.g., the 1964 flood) to contribute to these salmon habitat impacts. Limited water column chemistry monitoring in Redwood Creek generally indicates no problems with nutrients, dissolved oxygen, phosphorous, and nitrogen.

Table 12 summarizes the outputs for our preliminary EMDS analysis for Redwood Creek by subbasin. The model indicates significant problems with habitat suitability for salmonids for all subbasins except Prairie Creek. The "moderately suitable" condition for the roads factor reflects the significant work that RNSP has done in road decommissioning and upgrading on the lower Redwood Creek and Prairie Creek subbasins. RNSP and major private landowners are actively working to evaluate and improve roads in the middle and upper subbasins as well, so improvements in this factor can be expected over time in those subbasins.

Table 13: Major EMDS Watershed Model Suitability Ratings for Redwood Creek Subbasins.

Factor/Subbasin	Estuary	Lower Redwood Creek	Middle Redwood Creek	Prairie Creek	Upper Redwood Creek
WATERSHED CONDITION	- - -	-	- -	+	- -
UPLAND CONDITION	-	-	-	++	-
ROADS	++	++	- -	+	- -
STREAM CONDITION	- - -	-	- -	+	- -
REACH CONDITION	U	-	-	-	-

+++ fully suitable
++ moderately suitable
+ somewhat suitable
- somewhat unsuitable
- - moderately unsuitable
- - - fully unsuitable
U Undetermined

Watershed problem sources on the Redwood Creek watershed are located more on the middle and upper portions of the watershed, where steeper slopes, higher geologic instability, higher road densities, and more intensive land uses are found. Impacts of these upper watershed effects, sedimentation in particular, tend to concentrate in the mainstem and lower reaches of the watershed due to cumulative effects and lower stream gradient. One particularly complex salmonid habitat suitability issue—stream water temperature—needs additional analysis in light of the multifaceted interrelationships between stream water temperature and factors such as air temperature, streamside vegetation, channel width, groundwater influences, and basin size.

In general, there is a notable difference in stream habitat between the mainstem Redwood Creek its tributaries. The fundamental differences are related to the smaller size, higher gradient, and confined channel of the tributaries, particularly as compared to the low gradient, unconfined channel of the lower reach and most of the middle reach of mainstem Redwood Creek.

Redwood Creek Estuary

Introduction

The Redwood Creek estuary/lagoon is located approximately 3.5 miles from the town of Orick. Estuaries are links between freshwater and marine environments where mixing of sea water and freshwater creates environmental conditions that are well suited for the anadromous life history life strategy used by salmon, steelhead, and cutthroat trout. These fish pass through the estuary during seaward migrations as juveniles and as adults, gain access though the estuary to the freshwater during spawning migrations. The brackish water of the estuary provides an important area where salmonids can acclimate to changes in salinity as they move between the freshwater and marine environments. In addition, the mixing of seawater and freshwater that occurs in the estuary helps create a very productive environment for fish. Because of their high productivity and isolation from predators, estuaries are considered important nursery areas for juvenile fish including salmon, steelhead, and coast cutthroat trout. During summer months, a sand bar typically forms across the mouth of the estuary that blocks the flow of tidewater and creates a coastal lagoon.

Table 14: Estuary Subbasin Summary.

Redwood Creek Estuary		
Square Miles	5.36	
Acreage, Total	3,429	
Private Acres	2,007	
Federal Acres	1,422	
State Acres	0	
Principal Communities	Orick	
Predominant Land Use	Livestock grazing	
Predominant Vegetation Type	Pasture / Ag Land	
Miles of Anadromous Stream	3.89	
Low Elevation	0	
High Elevation	1,243	
Fish Species	chinook coho steelhead coastal cutthroat trout pacific lamprey prickly sculpin	starry flounder eulachon surf smelt night smelt tidewater golby shiner surfperch staghorn sculpin

Hydrology

See Appendix G. Material from this appendix will be incorporated here in a later draft.

Geology

The estuary of Redwood Creek is surrounded by slopes of Redwood Creek schist, which are locally overlain by remnants of uplifted marine terraces that form flat-topped ridge crests. Several rotational landslides as well as irregular slopes and debris-slide slopes have been identified on the south side of the estuary. Slopes north of the estuary are typically mantled with numerous earth flow complexes. Several small alluvial fans have built out upon the valley floor. Refer to the large map sheet for more information.

The sediment supply to the estuary is naturally high because of its location at the mouth of Redwood Creek. The sediment supply was enhanced by major storms during the last 50 years in 1955, 1964, 1972, 1975, and 1996-1997. Sediment accumulates in the estuary because of low gradient and natural estuarine backwater effects.

Disturbance in the watershed appears to have been particularly intense in the years immediately prior to park expansion in 1978. Timber harvesting methods tended toward clear cuts. Watercourse crossings were often poorly constructed, and typically did not have backup drainage structures to prevent runoff diversion in case a culvert plugged. Plugging and failure of a crossing could easily cascade to the next crossing downhill along the road creating excessive erosion off the edge of the road and in the receiving watercourse. Roads were often located on marginally stable ground.

Unengineered side cast roadway fills are susceptible to failure during foul weather, often delivering large amounts of sediment into the system.

The addition of the levee system in the mid-1960s has probably exacerbated the sediment problem within the estuary system by simplifying the channel, restricting the flow, and reducing the volume of the tidal prism. Channels need complexity and structure in order to create the hydraulic jumps required to move sediment through the system.

It should be noted here that estuaries form naturally. In this region, waves striking the coast at an angle (from the northwest, in this case) will distribute sediment in a southerly direction along the coast in a process known as littoral drift. Sand moving along the coastline in this manner accumulates naturally at the mouths of rivers and bays forming spits, which in turn create estuaries. Humboldt Bay, Big Lagoon, and the Redwood Creek estuary are examples of this process.

Vegetation

The estuary subbasin has the largest amount of agriculture land (420 acres) within the Redwood Creek basin. Most of this cover type is in permanent grazing land and pasture. Developed acres within this subbasin account for the largest amount of development within Redwood Creek. Approximately 50 acres have been developed in and around the community of Orick. Old growth redwood is also found within the subbasin, along with stands of cut over land that supports second growth conifers.

Land Use

Timber harvest operations within the estuary subbasin occurred prior to 1942. Most of the area had been converted to other land used such as pasture land, and development as part of the settlement of the Orick area. A total of 1,710 were converted to some other non- forested land use. This accounts for most of the converted land within the entire Redwood Creek Basin. Since 1945 a total of 563 acres were harvested in the area. These harvested areas have become re-established with conifers and some hardwood stands.

Fluvial Geomorphology

This section is pending completion of work by DMG.

Water Quality

Table 15: Estuary Subbasin Water Quality Monitoring Summary.

Estuary Subbasin Water Quality Monitoring Summary			
Parameter	**Sampling Period**	**Number of samples**	**Number of sites**
Percent of Fine Material (McNeil cores)	1983-1995	53	2
Temperature	1997-1998	continuous	1
Water Chemistry	1958-2001	quarterly	1
Stream Gage	1912, 1954-2001	continuous	1

Table 15 showing a summary of monitoring data compiled for the NCRWQCB 2001 water quality assessment for Redwood Creek. Refer to the attached appendix report for further information and an assessment of the data.

Water Column Chemistry

The main monitoring site for water chemistry data in the estuary of Redwood Creek is at the town of Orick, near the upper end of the estuary. Refer to Tables 8 and 9 in the NCRWQCB appendix report for USGS and StoRet data collected for dissolved oxygen, conductivity, pH and some limited nutrients sampled from 1958 until 1988. Thirty years of data indicate a slight increasing trend for DO and pH. These values present conditions that are influenced by tidal fluctuations and ocean inflow to varying degrees. There are a few additional monitoring sites closer to the mouth of Redwood Creek in the estuary. The data are scattered and scarce, but can be obtained at the USGS NWISweb website (USGS 2001).

The Surface Water Ambient Monitoring Program (SWAMP), administered by the North Coast Regional Water Quality Control Board, collected three samples at a site near the town of Orick in March-May, 2001, with mean dissolved oxygen of 10.3mg/L (water quality objective >8mg/L), pH at 7.7 (water quality objective 6.5-8.5), and conductance of 105umhos (water quality objective <220umhos). Samples for nitrogen and phosphorus were within normal limits. Future sampling efforts from the SWAMP program in addition to historical samples will extend trend lines for pH, dissolved oxygen and conductivity.

Temperature

Water temperatures in the estuary have exceeded the “fully suitable” range for salmonids since at least 1997 when monitoring first began, MWATs being higher than 65F for both years of available data. Currently the estuary is monitored at a site located between the levees, south of the town of Orick. Continuous temperature data show large fluctuations coinciding with times when the sandbar at the mouth of Redwood Creek is breached or perhaps due to interactions with a cold water “wedge” from tidal influences. High temperatures are a concern since this area provides critical habitat for salmonid growth. The mouth of Redwood Creek is very wide and vegetation along the channel consists of grasses and small shrubs that do not shade the channel. Influence from daily fog and cool ocean waters may be the largest factor keeping temperatures cooler but not within the "fully suitable" range for salmonid growth.

Sediment

The only site containing data for in-channel sediment was sampled from the mainstem near the town of Orick by USGS. Redwood Creek at Orick was sampled for percent of fine materials for fractions of <1mm, <4mm and <8mm every two years from 1983 to 1995. However, the TMDL target of <30% for fines <6.5mm was exceeded six out of seven times by the <4mm fraction recorded. The data do not fall into TMDL targets classes of <0.85 and <6.5mm as critical to salmonid production. However, data for the lower Redwood Creek sites show that from 1989 to 1991 the TMDL target for the <6.5mm fraction was exceeded, recognizing that the data is scattered and scarce. See the RWQCB Water Quality appendix for detailed information. As seen in the upper, middle and lower subbasins, there is an abundance of coarse, gravel sized material in the streambed. This may represent conditions that should be expected in the depositary area of an estuary.

Fish History and Status

The Redwood Creek estuary/lagoon provides critical habitat in the life cycle of anadromous salmonids and many other valuable fishery resources. Estuaries are the nexus between freshwater and marine environments which anadromous salmonids pass through as juveniles during seaward migrations and where adults gain access to their natal rivers during spawning migrations. Estuaries are recognized as valuable salmonid nursery areas because they provide abundant food supplies, they offer protection from predators, and are diverse habitat areas. Several fish species, have adopted an estuarine residency, particularly for reproduction and early stages of their life cycle. Some species deposit eggs or give live birth directly in estuaries, while others have evolved mechanisms which help the delivery of their young into estuaries by ocean tides or riverine currents. Fish including salmonids that utilize estuaries for an important part of their life cycle are referred to as estuarine-dependant. The estuarine rearing is a strategy that adds diversity to juvenile salmonid life history patterns and likely increases the odds for survival of a species encountering a wide range of environmental conditions in both the freshwater and marine environments. An extended estuarine residency may be especially beneficial for salmonids from rivers where low summer flows or warm water temperatures severely limit summer rearing habitat.

Fish Habitat Relationship

The present condition of the Redwood Creek estuary/lagoon has limited the biologic function and therefore production of salmonids of Redwood Creek. Over the past 100 years, the physical structure of the estuary has been modified by levee construction, removal of riparian forests, conversion of wetlands to pasture lands, and artificial breeching. These modifications combined with excessive sediment accumulations have reduced the size of the estuary and wetland areas, reduced the tidal prism, and altered drainage patterns all which impair the physical function and the ability of the estuary/lagoon to fully support salmonids.

Management alternatives have been developed by RSNP and others to improve the estuarine habitat. Any plans will require private landowner and local stakeholders cooperation.

Table 16: Redwood Creek Estuary Subbasin EMDS Watershed Model Suitability Ratings by Planning Watershed.

Factor//Watershed Unit	Estuary Subbasin	Skunk Cabbage Creek
CALWATER ID		1107.100203
WATERSHED CONDITION	- - -	- - -
UPLAND CONDITION	-	-
UPLAND COVER	- -	- -
CANOPY	- -	- -
EARLY SERAL	+++	+++
SLOPE STABILITY	++	++
LAND USE	-	-
ROADS	++	++
ROAD USE	U	U
STREAM CROSSINGS	+++	+++
ROAD DENSITY BY HILLSLOPE POS.	+++	+++
ROAD DENSITY UNSTABLE	++	++
ROAD PROXIMITY TO STREAMS	+++	+++
PASSAGE BARRIERS	U	U
STREAM CONDITION	- - -	- - -
REACH CONDITION	U	U
WATER TEMPERATURE	U	U
STREAM FLOW	U	U
RIPARIAN	- - -	- - -

+++ fully suitable
++ moderately suitable
+ somewhat suitable
- somewhat unsuitable
- - moderately unsuitable
- - - fully unsuitable
U Undetermined

Subbasin Issues

<u>**Working Hypothesis**</u>: ***The present state of estuarine habitat is limiting the production of salmonids in Redwood Creek.***

<u>**Supporting Findings:**</u>

- Estuaries provide critical habitat for all anadromous salmonids species.
- Land use has converted native vegetation (Sitka spruce, redwood, willows, etc.) to mostly pasture, urban (town of Orick), and rural residential development.
- Channel confined due to levee construction.

- Sediment from upstream has been delivered by storm events and has accumulated in the low gradient estuarine channel.

- Sources of upstream sediment include highly erodible earth materials, mass wasting, seismic activity, and land use.

- Water temperatures in the estuary, as a result of warming effects upstream, periodically exceeds a level that is fully supportive of salmonids.

- Slough channel in northern portion of estuary has been cut off; this in combination with sediment storage in the estuary, has resulted in a reduction in tidal prism, which contributes to a reduction in the estuary's ability to transport fine sediment to sea; also loss of rearing habitat.

- Anecdotal historical information describes abundant coastal cutthroat fishery present in the estuary; Steve needs to scope current abundance information.

Contrary Findings:

None noted.

Recommendations:

- Work with responsible agencies and landowners to improve physical structure and biologic function of the estuary.

- Restore natural water circulation patterns

- Explore opportunities for levee modifications that would improve estuarine habitat conditions.

- Continue efforts such as road improvements and decommissioning and other prand throughout the basin to reduce sediment delivery to Redwood Creek and its tributaries.

- Ensure that adequate streamside protection zones are used to reduce solar radiation and moderate air temperatures in order to reduce heat inputs to Redwood Creek and its tributaries. Where current canopy is inadequate and site conditions are appropriate, use tree planting and other vegetation management techniques to hasten the development of denser and more extensive riparian canopy.

- Maintain continuous temperature monitoring efforts in the estuary.

- Continue monitoring anadromous salmonid populations efforts conducted by RNSP.

Prairie Creek Subbasin

Introduction

The Prairie Creek watershed is largely under management by the Redwood National and State Parks (RNSP). Because portions of the land in this watershed are relatively undisturbed and retain old growth forest characteristics, the Prairie Creek watershed offers some of the most pristine or refugia type fisheries habitat within the coastal redwood region. Prairie Creek and its eight major tributary streams support populations of chinook salmon, coho salmon, steelhead, and coastal cutthroat trout.

Table 17: Prairie Creek Subbasin Summary.

Prairie Creek Subbasin		
Square Miles	39.59	
Acreage, Total	25,339	
Private Acres	463	
Federal Acres	18,247	
State Acres	6,629	
Principal Communities	Orick	
Predominant Land Use	Park Land	
Predominant Vegetation Type	Redwood Forest	
Miles of Anadromous Stream	22.48	
Low Elevation	26	
High Elevation	2,270	
Fish Species	chinook coho steelhead coastal cutthroat trout rainbow trout sea lamprey	pacific lamprey prickly sculpin coastrange sculpin 3 spine stickleback sucker

Hydrology

See Appendix G. Material from this appendix will be incorporated here in a later draft.

Geology

The Prairie Creek subbasin contains Prairie Creek, Little Lost Man Creek and Skunk Cabbage Creek. The Grogan fault zone trends southwest of and parallel to Squashan Creek; the fault may control the location of the creek. However, the fault zone is covered in this area by deposits of the Prairie Creek Formation. Other sub parallel structural features (faults or lineaments) may influence the locations and orientations of Fern Canyon, Little Lost Man Creek and Prairie Creek.

This part of the watershed is roughly defined by Skunk Cabbage Creek to the southwest, Little Lost Man Creek to the southeast and Prairie Creek to the north. The Pliocene-Pleistocene Prairie Creek Formation dominates the bedrock exposures west of Highway 101. The Prairie Creek Formation is moderately cemented sand and gravel deposited at the ancestral mouth of the Klamath River. A small gold rush in the 1850s involved prospectors working beach placers derived from the Prairie Creek Formation at Gold Bluffs beach.

This subbasin appears to have been domed and uplifted across a broad zone extending from Orick northward to the town of Klamath. Major drainages trend northwest (Skunk Cabbage Creek); subsidiary drainages are nearly perpendicular to the trend of the main watercourse and are oriented to southwest and west-southwest. The stream orientations may be controlled by a set of fractures in the underlying bedrock.

The major drainages on west side of Prairie Creek generally have gentle gradients at their heads and flat-floored valleys. Stream profiles steepen towards the modern Redwood Creek channel rather than starting steep and flattening downstream as is more typical of drainage profiles. This appears to be in response to the regional deformation.

Hanging valleys visible along Gold Bluffs provide geomorphic evidence of stream capture. Some of the drainages west of Highway 101 have seasonal waterfalls. Main drainages do not appear to be actively moving sediment at this time because there is little incision except around the periphery as the system starts to adjust to lower base level.

Drainages east of 101 are steeper and underlain by the Coherent Unit of Lacks Creek. Outcrops at higher elevation have been uplifted along a normal fault (Kelsey, 1989, unpublished mapping); the eroded fault scarp occurs where Franciscan assemblage rocks exposed are below the Prairie Creek Formation.

Mass wasting features, particularly debris slides, are common in the Prairie Creek Formation (PPpc). Steeper terrain & debris slide slopes are present in the southern half of the subbasin. This may be caused by a change in the underlying bedrock. Occasional inner gorges are present near the lower portions of the slopes east of Highway 101.

The southeast portion of the drainage supports numerous rotational landslides and earth flows and is largely underlain by the Coherent Unit of Lacks Creek (KJfl). An excessive amount of sediment reportedly made its way into the system as a result of the Highway 101 bypass construction. Exposed sandy fills were highly susceptible to erosion, and roadway sanding during icy conditions in the winter continues to pose a major sedimentation problem.

Channel bottoms are naturally fine grained because of the sandy parent material and the low channel gradients. The highway activities have probably exacerbated this situation.

Tributaries are steep A+ channels on the eastern side of Prairie Creek, whereas channels on the west side are less steep and consist of Rosgen A, B or Fb, and C categories.

May Creek and Lost Man Creek are the two Calwater units in the Prairie Creek subbasin.

Vegetation

Vegetation within this subbasin consists almost entirely of conifers. These conifer stands are, for the most part, two different types. Areas of old growth Redwood and Douglas-fir occupy most of the northern portion of the subbasin. Second growth redwood forests have become established on the previously harvested lands in the subbasin. These cut over stands now support healthy well stocked stands. Some of these second growth stands appear to be overstocked and are loosing vigor. Approximately 40 acres is prairie grassland. One area (72 acres) classified as barren follows the new section of Highway 101, commonly referred to as the “bypass”. The areas (48 acres) which have been converted to another land use are several parcels located along the lower section of Prairie Creek. The largest area is where a currently operating sawmill is located. The land base in this subbasin appears to be productive and does not exhibit any significant vegetation impacts.

Land Use

Some early tractor logging started in the late 1930s but does not become highly utilized until after the end of World War II. By 1948 the use of tractors had become the primary mover during yarding operations. It was during this time period that a majority of the roads in the May Creek, Prairie Creek, Skunk Cabbage and Lost Man Creek watershed appear to have been constructed. Routes of these haul road systems, for the most part, followed the drainages themselves. Landings, some quite extensive, were also built in or along the watercourse channel. A total of 3,21 acres were harvested within the Prairie Creek subbasin from the early 1940s until 1978. Most the major harvest operations occurred during the period from 1954 to 1963 in the area of May Creek. These harvested areas now support stands of well stocked thrifty young growth forests.

Fluvial Geomorphology

This section is pending completion of work by DMG.

Water Quality

Table 18: Prairie Creek Subbasin Water Quality Monitoring Summary.

Prairie Creek Subbasin Water Quality Monitoring Summary			
Parameter	**Sampling Period**	**Number of samples**	**Number of sites**
Percent of Fine Material (McNeil cores)	1974, 1987	16	3
Temperature	1974, 1997-2001	continuous	6
Water Chemistry	1973-1977, 1981	quarterly	7

Table 18 showing a summary of monitoring data compiled for the NCRWQCB 2001 water quality assessment for Redwood Creek. Refer to the attached appendix report for further information and an assessment of the data.

Water Column Chemistry

Eight tributary stations in the Prairie Creek subwatershed were monitored by USGS between 1973 and 1977. Data for dissolved oxygen ranged from 8-13mg/L (water quality objective >8mg/L), pH ranged from 6 to 8.3 (water quality objective 6.5-8.5), and conductivity ranged from 20-130umhos (water quality objective <220umhos). Water quality samples taken in Prairie Creek and its tributaries indicate compliance with Basin Plan objectives and no noticeable trends were observed.

Temperature

The Prairie Creek subwatershed is greatly influenced by coastal fog and has dense canopy cover, both functioning to moderate water temperatures. This tributary to Redwood Creek hosts a large population of the old redwoods which provide streamside cover over the channel. Existing data show maximum MWATs of 57F at two locations on Prairie Creek from 1997-2001. Three tributaries to Prairie Creek have MWATs around 57F with one recording of 64F in 1974. Unfortunately, the mouth of Prairie Creek is not monitored at the confluence of Redwood Creek. Consequently, how much of an influence this tributary has on cooling the mainstem is unknown. This subwatershed contains optimal channel shade and climate conditions creating “fully suitable” water temperatures for salmonids.

Sediment

Sediment in Prairie Creek has been monitored at 3 sites since 1974. Much of the existing data consists of suspended sediment and flow. This part of the watershed has not been sampled for particle size (D_{50}) composition. Percent fines data from core samplers for the Prairie Creek watershed consists of two samples at Lost Man Creek from 1974 and three samples at Little Lost Man Creek from 1974 and 1987. The 1974 samples on Lost Man and Little Lost Man Creeks exceeded the TMDL target of less than 14% fines <0.85mm. Percent fines data for this subwatershed is scattered and scarce. See the RWQCB Water Quality appendix for detailed information.

Intensive fine and suspended sediment sampling occurred in Prairie Creek during 1988-90 when the California Department of Transportation constructed a highway bypass around and through the watershed and for ten years after construction was completed. These data are not included in this assessment due to the specific nature of the sampling. Most of the monitoring from this incident developed from a violated water quality permit and was not a long-term sampling project to monitor and assess the health of Prairie Creek. Data collected under permit requirements showed that impacts to salmonid habitat did occur and Prairie Creek may still be coping with the affects of the construction. Presently, the RNSP and CalTrans monitor lasting impacts to Prairie Creek. Detailed information about the Prairie Creek Highway 101 bypass can be found in Klein (1993), Coey (1998), Roelofs (1999), Welsh (1999) and many others.

Fish History and Status

The Prairie Creek watershed supports populations of chinook salmon, coho salmon, steelhead, and coast cutthroat. There are approximately 22.5 miles of stream habitat accessable to anadromous salmonids in the Prairie Creek subbbasin. Table 19 presents a summary streams, species present, and number of stream miles accessible to anadromous salmonids in the Prairie Creek subbasin. The Prairie Creek watershed is largely under management by the Redwood National and State Parks (RNSP). Stream reaches within the Prairie Creek watershed exhibits some of the most pristine or refugia type fisheries habitat within the coastal redwood region.

Humboldt State University, Forest Sciences Project, Redwood National and State Parks (RNSP) and others have conducted fish studies within the Prairie Creek subbasin. Due to the large quantity of raw data to review and summarize describing fish populations of Prairie Creek watershed, these data are not ready to be presented in this draft report. We anticipate a detailed discussion of these data in the next draft report. We do know that Prairie Creek sub basin provides a significant amount of habitat for coho and chinook salmon and steelhead and cutthroat trout and that it produces the most coho salmon in the Redwood Creek basin.

Table 19: Streams, Species Present, and Number of Stream Miles Accessible to Anadromous Salmonids in the Prairie Creek Subbasin.

Stream	***Species Observed***		***Stream Length (mi) Access***	***References***
Prairie Creek	coho chinook steelhead coastal cutthroat trout Pacific giant salamander	3 spine stickleback coast range sculpin prickly sculpin Pacific lamprey tailed frog brook lamprey	34.18	
Lost Man	coho chinook steelhead coastal cutthroat trout	Pacific lamprey tailed frog Pacific giant salamander	2.92	DFG 2001 & 1966 Stream Surveys, carcass surveys 1984-1992, RPN/USFS barrier study notesF1995 notes, Neilands 1990, Brown 1988 (referencing CDFG stream surveys and Hofstra personal communication)

Stream	***Species Observed***		***Stream Length (mi) Access***	***References***
Little Lost Man	coho chinook steelhead Pacific giant salamander	Pacific lamprey coastal cutthroat trout sculpin sp. tailed frog larvae	1.99	Klatte and Roelofs 1997, D.J. Manning, et al. 1996, HSU fisheries graduate student, USFS/RNP barrier study 1995, RNP/USFS-RSL revisit of 1981 thesis sites field notes, Neillands 1990, Brown
Brown Creek	coho steelhead coastal cutthroat trout pacific giant salamander pacific lamprey	chinook tailed frog red legged frog sculpinsp. trout sucker	1.37	Klatte and Roelofs 1997, USFS/RNP barrier study 1995, Neilands 1990, Brown 1988, 1988 (referencing CDFG stream surveys)
Boyes Creek	coho chinook steelhead cutthroat/steelhead	coastal cutthroat trout 3 spine stickleback sculpin sp. sucker		Klatte and Roelofs 1997, Brown 1988, 1988 (referencing CDFG stream surveys and Chuck Warren personal communication)
Streelow Creek	coho steelhead coastal cutthroat trout pacific lamprey frog	cutthroat/steelhead sculpin sp. 3 spine stickleback pacific giant-salamander	1.30	RNP/USFS-RSL revisit of 1981 thesis sites field notes, Neillands 1990, Brown 1988,
Godwood Creek	coho steelhead cutthroat/steelhead sculpin sp.	chinook coastal cutthroat trout	1.30	Klatte and Roelofs 1997, Neillands 1990, Brown 1988,
Skunk Cabbage Creek	coho steelhead	coastal cutthroat trout chinook	0.56	Brown 1988
May Creek	steelhead coastal cutthroat trout pacific giant salamander sucker	cutthroat/steelhead 3 spine stickleback sculpin sp. pacific lamprey	0.37	CDFG 2001, 80 & 76 stream surveys, Klatte and Roelofs 1997, USFS? RNP barrier study notes, Neillands 1990, Brown 1988 (ref. CDFG surveys, C Warren personal communication)

Fish Habitat Relationships

The Prairie Creek watershed is largely under management by the Redwood National and State Parks (RNSP). Because much of the land in this watershed is relatively undisturbed, the Prairie Creek watershed offers some of the most pristine or refugia type fisheries habitat within the coastal redwood region.

The construction of the Highway 101 by-pass created a large sedimentation event in 1989 that impacted coho spawning and rearing habitat in the Prairie Creek watershed from Brown Creek to the confluence with Redwood Creek. A 1997 population estimate of 24,588 migrating juvenile coho was made for the portion of the watershed above Streelow Creek (Klatte and Roelofs 1997).

Prairie Creek Subbasin Summary

This section presents a summary of the EMDS evaluation results (Table 20) and a comprehensive discussion of the watershed condition for the Prairie Creek subbasin. The subbasin evaluations were determined by calculating a mean, area weighted watershed condition value from the Lost Man and May Creek planning watersheds. The evaluation results of each subbasin are presented in the EMDS section of the Redwood Creek Watershed Profile. The overall condition of the planning watersheds were determined by the results of the following networks:

- Roads overall
- Stream condition
- Stream reach condition
- Upland cover
- (Passage barriers, currently with no data)

Network details are described in Appendix A and maps showing EMDS results are provided in Appendix B.

Table 20: Prairie Creek Subbasin EMDS Watershed Model Suitability Ratings by Planning Watershed.

Factor//Watershed Unit	Prairie Creek Subbasin	Lost Man Creek	May Creek
CALWATER ID		1107.100104	1107.100201
WATERSHED CONDITION	+	+	+
UPLAND CONDITION	++	+	++
UPLAND COVER	+++	+++	+++
CANOPY	+++	+++	+++
EARLY SERAL	+++	+++	+++
SLOPE STABILITY	++	++	+++
LAND USE	+	-	++
ROADS	+	-	++
ROAD USE	U	U	U
STREAM CROSSINGS	+	+	++
ROAD DENSITY BY HILLSLOPE POS.	++	++	+++
ROAD DENSITY UNSTABLE	-	- -	+++
ROAD PROXIMITY	-	-	+
PASSAGE BARRIERS	U	U	U
STREAM CONDITION	+	-	+
REACH CONDITION	-	-	-
WATER TEMPERATURE	U	U	U
STREAM FLOW	U	U	U
RIPARIAN	++	+	++

+++ fully suitable
++ moderately suitable
+ somewhat suitable
- somewhat unsuitable
- - moderately unsuitable
- - - fully unsuitable
U Undetermined

The overall watershed condition rating from the EMDS model was “somewhat suitable” for the Prairie Creek subbasin. This was the best rating of all Redwood Creek sub basins. Table 20 shows the watershed condition summaries for each of the planning watersheds of the Prairie Creek subbasin

Roads were rated “somewhat suitable” by EMDS evaluations. The only “unsuitable” ratings for this evaluation were due to the number of roads in close proximity to streams and located unstable slopes in the Lost Man planning watershed.

We recommend decommissioning or upgrading roads located the Lost Man planning watershed in accordance with existing or future road assessment surveys, especially those located on unstable slopes and near streams.

The stream condition evaluation for the Prairie Creek subbasin received a rating of “somewhat suitable”. The results form the stream reach condition component of this network evaluation likely made a significant contribution to this rating.

We use a random systematic site selection process to collect data to populate the stream reach condition EMDS knowledge base (see methods section above). Maps showing EMDS stream reach condition results are presented in Appendix B. Details of the stream reach condition evaluations are presented in Appendix D.

The overall stream reach condition evaluation for the Prairie Creek subbasin all rate at “somewhat unsuitable’. The stream reach condition evaluation is based on habitat factors collected from stream surveys and is part of the overall stream condition evaluation (Appendix A). The stream reach condition evaluation results show the number of deep, complex pools are generally “fully unsuitable” except for one reache located on Prairie Creek and a one reach on a tributary to Lostman Creek which received a “fully suitable” rating. The pool depth and shelter complexity scores also combined to form a generally “moderately suitable” condition rating for the pool quality evaluation. Embeddedness ratings ranged from “fully suitable” to “moderately unsuitable”. Canopy density ratings were generally “fully suitable”. Water temperature was generally within the fully supportive range.

The upland condition of the Prairie Creek subbasin was rated as “moderately suitable” by the EMDS evaluation. Upland cover, canopy, and early seral components of the Upland condition model all rated as “fully suitable”. Land use and road components both rated as “somewhat unsuitable” which reduced the overall upland condition score.

Subbasin Issues

Working Hypothesis: ***The Prairie Creek subbasin provides relatively high quality habitat for native anadromous salmonids.***

Supporting Findings:

- All four species of native anadromous salmonids are present in this subbasin.

- A high proportion subbasin stream reaches contain the low-gradient habitat preferred by coho.

- The high rate of geologic uplift in the subbasin, creates a potential for high natural sedimentation rates; sand and gravel are the main components of the sediment input yielded by the overlying geologic formation.

- Water temperatures are within the range of being fully supportive of salmonids.
- Water column chemistry samples taken within the subbasin comply with Basin Plan objectives.
- Land management in portions of the watershed has been relatively limited, resulting in significant extent of mature or old growth conifer vegetation that provides dense canopy and large woody debris recruitment potential.

Contrary Findings:

- Surface and drainage alterations associated with the Highway 101 bypass are resulting in the generation and delivery of readily observed quantities of sediment into Brown and Boyes Creeks.
- In-channel sediment sampling indicates that the percent fines are higher than TMDL targets in Lost Man and Little Lost Man Creeks.

Recommendations:

- Ensure that this high quality habitat is protected from degradation.
- Caltrans should take steps to better address sediment delivery from the Highway 101 bypass.
- Continue salmonid population monitoring conducted by Humb oldt State University and RNSP.

Lower Redwood Creek Subbasin

Introduction

The Lower Redwood Creek watershed is managed by the RNSP. Lower Redwood Creek subbasin includes the area above the confluence of Redwood and Prairie Creeks to the confluence of Redwood and Devil's Creek. There is a notable difference in stream habitat between the mainstem Redwood Creek its tributaries. The fundamental differences are related to the smaller size, higher gradient, and confined channel of the tributaries compared to the low gradient, unconfined channel of the lower reach of mainstem Redwood Creek. The Lower Redwood Creek subbasin supports populations of chinook salmon, coho salmon, steelhead, and coastal cutthroat.

Table 21: Lower Redwood Creek Subbasin Summary.

Lower Redwood Creek Subbasin	
Square Miles	69.51
Acreage, Total	44,488
Private Acres	275
Federal Acres	44,212
State Acres	0
Principal Communities	
Predominant Land Use	Park Land

Lower Redwood Creek Subbasin	
Predominant Vegetation Type	Redwood Forest
Miles of Anadromous Stream	24.47
Low Elevation	26
High Elevation	1,286
Fish Species	chinook, coho, steelhead, coastal cutthroat trout, rainbow trout, pacific lamprey, coastrange sculpin

Hydrology

See Appendix G. Material from this appendix will be incorporated here in a later draft.

Geology

This part of the watershed is defined by the confluence of the main stem with McArthur Creek to the north and Devils Creek to the south. The Schist of Redwood Creek (KJfr) dominates the bedrock in this part of the drainage. The Incoherent Unit of Coyote Creek (KJfc) and the Coherent Unit of Lacks Creek (KJfl) are seen forming two relatively narrow bands immediately east of the Grogan Fault. The Coherent Unit of Lacks Creek forms the steeper uplands and the Incoherent Unit of Coyote Creek forms the lower, earth flow-dominated slopes close to Redwood Creek. The watercourse below the Bridge Creek confluence appears to be a depositional reach with a relatively normal distribution of inner gorge debris slides. The channel from Devils Creek to Bridge Creek, however, is the area with the biggest debris slides in the entire watershed (as mapped from the 1978 aerial photographs). Some of these inner gorge debris slides extend 500 to 100 feet upslope.

The lower part of Redwood Creek is relatively straight and follows the Grogan fault zone down to the mouth of Dolason Creek. Streamside landslides are abundant along this reach within the fault zone. Below the mouth of Dolason Creek, Redwood Creek again veers westward into the Redwood Creek Schist. Below Bridge Creek, the next tributary, Redwood Creek widens. This lower, wider, and flatter stretch contains massive stream bars and some elevated terraces, including the terrace that is the site of the Tall Trees Grove in Redwood Park. Downstream, the main stem makes its final westward bend toward the ocean. It passes through the very small town of Orick where the main stem is confined by engineered levees all the way to the estuary.

The abundance of debris slides along the relatively straight reach may be related to a zone of weak, sheared rocks close to the fault. Another cause may be elevated groundwater levels related to extensive harvest operations upslope on either side of the Redwood Creek channel immediately prior to this part of the watershed being incorporated into the Park. Lower evapotranspiration, interception, and resultant higher groundwater may have combined with flooding during the 1975 storm season.

The northeast-facing slope above this section of channel stands strikingly out from the rest of the basin as it is relative uniform and has few large landslides. The upper Bridge Creek channel may be structurally controlled because it closely flows an aerial photograph lineament that extends south to Panther Creek.

The lower part of Redwood Creek is straight and follows the Grogan fault zone from Highway 299 to the mouth of Dolason Creek. Streamside landslides are abundant along this reach within the fault zone. Below the mouth of Dolason Creek, the course of Redwood Creek veers westward into the Redwood Creek Schist. Below Bridge Creek, the next tributary, Redwood Creek widens. This lower, wider, and flatter stretch contains massive stream bars and some terraces, including the terrace of the Tall Trees Grove in Redwood National and State Parks. Downstream, the main stem makes its final westward bend toward the ocean. It passes through the small town of Orick where the main stem is confined by engineered levees all the way to the estuary. The levees were built after the flood of 1964 to protect the town and adjacent farmland from flooding.

Vegetation

A full spectrum of vegetation is found within the lower Redwood Creek subbasin. This subbasin contains 34,716 acres of forested landscape. Redwood, both old-growth and second growth, occupy most of this type. Douglas-fir also is a significant component of the forest. Approximately 750 acres is classified as grassland and 8,452 acres are stocked with hardwoods, mainly tanoak. Areas of Oregon white oak are found along the upper ridges of the subbasin in association with the grasslands. The land base in this subbasin appears to be productive and does not exhibit any significant vegetation impacts.

Land Use

The highest percentage of the area logged was during the period of 1962 to 1978. During this 16 year period 27 percent of the drainage was harvested. This amounts to approximately 49,000 acres, an average of over 3,000 acres per year. Most of this harvesting was centered within the areas of the watershed that would eventually become Redwood National Park. The second most active harvesting period was from the period of 1954 to 1962. During this time span of eight years 14 percent of the watershed was harvested. It should also be noted that from 1954 to 1978 timber harvesting within the Redwood Creek Drainage was at nearly even annual levels. The rate of harvest was fairly even at approximately 3000 acres per year being cut. A majority of this acreage was tractor yarded. Ground disturbance resulting from these prolonged operations is extensive, with some areas exhibiting well over 75 percent of the ground surface being disturbed. The use of tractor constructed skid trails, epically on the steeper slopes, is very evident. In some cases there appears to be a trail leading to every stump or log in the area.

Logging prior to 1942 was accomplished with the use of steam donkey skidding systems. Some harvesting was done in the headwaters of Devils Creek and Panther Creek. Some acreage in the vicinity of the mouth of Minor Creek and near the headwaters of Durdee Creek was also harvested with tractors. The area above Orick along the Bald Hills Road had been logged. Additional logging also took place in the area of Tom McDonald Creek, Devils Creek and High Prairie Creek

Several general observations were also noted from the various air photo years in regards to harvest methods. During the decade of the 1950s and early 1960s clear cuts were very large and extensive. Clear-cut units originating in the mid 1970s and later were much small with buffer zones between the cut blocks. With the introduction of cable systems in 1972 the road networks were beginning to be visible along the ridges and mid slope locations. Although the old roads still were located along channel bottoms, there was a lack on new road construction in these areas.

Harvest rates within the lower subbasin were very uniform when comparing the acres of timber harvested during various time periods and events. The time period from 1945 to 1955 was the initial harvest entry into the subbasin until the 1955 flood. Period two is that time from the 1955 flood until the 1964 flood. The few years from the 1964 flood until the initial park purchase makes up the third period. The final time period is from 1969 until the second park expansion of 1978. The annual rates of harvest from 1956 until the final harvest in 1978 appear to be fairly even.

Table 22: Harvest Rates and Acres Logged within Lower Redwood Creek from 1945 to 1978.

Time Period Comparison		
Time Period	***Harvest Acres***	***Annual Average***
1945 - 1955	3,593	326
1956 - 1964	9,627	1,069
1965 - 1968	4,365	1,120
1969 - 1978	11,069	1,106

Fluvial Geomorphology

Tributaries are generally steep A+ channels in their headwaters. The main stem of Redwood Creek varies between a B, C, Cb, and F channel. In the lowest part of the lower basin, Redwood Creek is a Rosgen DA multiple channel.

Water Quality

Table 23: Lower Redwood Creek Subbasin Water Quality Monitoring Summary.

Lower Redwood Creek Subbasin Water Quality Monitoring Summary			
Parameter	**Sampling Period**	**Number of samples**	**Number of sites**
Percent of Fine Material (McNeil cores)	1979, 1983, 1994	10	5
Temperature	1996-2001	continuous	4
Water Chemistry	1960-1980	quarterly	26

Table 23 showing a summary of monitoring data compiled for the NCRWQCB 2001 water quality assessment for Redwood Creek. Refer to the attached appendix report for further information and an assessment of the data.

Water Column Chemistry

USGS monitored 26 sites in the lower Redwood Creek basin between 1970 and 1980. Most of the sites were sampled from 1974-1975. Three sites are along the mainstem and 23 sites are on tributaries. Data for dissolved oxygen ranged from 7-13mg/L (water quality objective <8mg/L), pH ranged from 5.5 to 8.5 (water quality objective 6.5-8.5), and conductivity ranged from 25-250umhos (water quality objective <220umhos). Samples from the lower watershed area show compliance with Basin Plan water quality objectives and no noticeable trends were observed.

Temperature

Temperature data for lower Redwood Creek were collected at four locations, two along the mainstem and two at tributaries. Maximum weekly average temperatures for Bridge Creek have steadily resided around 60F from 1996 to 2001. This consistent MWAT is may be a result of canopy and channel protection offered by the RNSP. Although MWAT temperatures are steady, they just fall within the “fully suitable” range for salmonid protection. After leaving Redwood Valley in the middle subbasin, the mainstem is not monitored until Tom McDonald Creek, 15 miles downstream. However we noticed that MWAT temperature on the mainstem averages 70F at Tom McDonald Creek and that warm 72F water flowing from the middle subbasin is cooled about 2 degrees when it reaches Tom McDonald Creek. Redwood

Creek flows through patches of giant trees along the channel in this part of the subbasin that may provide enough shade to lower temperatures even further. Fog influence begins to take effect just before the confluence with Prairie Creek, decreasing air temperatures and further cooling the stream. Shade covering the channel, fog and, to an unknown extent springs and underflow, may help to reduce temperatures from 70F at the Tall Trees Grove to 67F upstream of the confluence with Prairie Creek just before flowing into the estuary (maximum MWATs for 1997-2001).

Janda (1975) states that summer maximum water temperatures in the lower basin are decreased because of taller and more abundant riparian vegetation and summer fog that prevents sunlight from reaching the water surface. Maximum MWATs are slightly cooler in the lower subbasin than in the middle, but temperatures exceed the “fully suitable” range even with contributions from cold water tributaries and fog influence.

Sediment

The lower subbasin of Redwood Creek was sampled 14 times at 7 sites to determine the amount of fine materials present in the channel. Sites at McArthur and Harry Weir Creeks, the mainstem up and downstream of Tall Trees Grove, and upstream of the confluence with Prairie Creek were each sampled for fine sediment using core samplers in 1979 and 1994 by the RNSP. Not all the available data fell into TMDL targets classes as critical to salmonid production. However, data for lower Redwood Creek sites show that samples for the <4mm fraction of fine sediment exceeded the <6.5mm TMDL target, recognizing that the data is scattered and scarce.. As seen in the Upper and Middle Redwood Creek subbasins, there is an abundance of coarse, gravel sized material in the streambed. See the RWQCB Water Quality appendix for detailed information.

According to the geomorphology examination conducted by the Division of Mines and Geology, the channel in this area is wide with a low gradient and contains terraces and large gravel bars. Their findings may help to explain the presence of large materials in the channel. See the Department of Conservation, Division of Mines and Geology fluvial geomorphology section of the appendix report to the Redwood Creek NCWAP 2001 Synthesis Report.

Fish History and Status

The lower Redwood Creek subbasin supports populations of chinook salmon, coho salmon, steelhead, and coast cutthroat. There are approximately 5.3 miles of tributary streams and 19.2 miles of redwood Creek mainstem accessable to anadromous salmonids in the lower subbasin. Table 24 presents streams, species present, and number of miles in each stream accessible to anadromous salmonids in the lower Redwood Creek subbasin.

Juvenile coho salmon were observed in Tom McDonald Creek, Bridge Creek, and Elam Creek (Dana McCanne unpublished data) during recent fish surveys conducted by the Department of Fish and Game and the Forest Sciences Project. Age 1+ and 2+ Coast cutthroat were observed in Forty-four Creek. Although no quantitative estimates are available, we generally feel that fish densities are relatively low in the streams we sampled. This is also true for juvenile steelhead, which is the most abundant and widely distributed species of all salmonids in the lower basin. Tom McDonald had the highest numbers of coho of all streams survey of the lower subbasin. Chinook were not observed, but they likely had migrated to the estuary or ocean prior to any fish surveys were conducted.

Table 24: Streams, Species Present, and Number of Stream Miles Accessible to Anadromous Salmonids in the Lower Redwood Creek Subbasin.

Stream	Species Observed		Stream Length (mi) Access	References
Bridge Creek	coho chinook steelhead coastal cutthroat trout Pacific giant salamander	bufo sp. sculpin sp. Pacific lamprey yellow legged frog western toad	1.99	DFG 2001 & 1966 Stream Surveys, Brown 1988 (Hofstra personal communication), USFS/RNP barrier study notes, Field note book Anderson, Mclelland
Tom McDonald Creek	coho chinook steelhead coastal cutthroat trout cutthroat/steelhead hybrid	Pacific lamprey coastal cutthroat trout sculpin sp. Pacific giant salamander	1.30	RNP 2000 surveys, Brown 1988, Neillands 1990, RNP/USFS-RSL revisit of 1981 thesis sites field notes, DFG 1966 stream survey
Macarthur Creek	coho steelhead coastal cutthroat trout Pacific giant salamander cutthroat/steelhead hybrid	tailed frog yellow legged frog sculpin sp.	0.50	Brown 1988, Neillands 1990, RNP/USFS-RSL barrier study - 1995 notes
Copper Creek	steelhead		0.31	Brown 1988
Elam Creek	steelhead coastal cutthroat	cutthroat/rainbow sculpin sp.	0.31	Brown 1988, Neillands 1990
Devils Creek	steelhead Pacific giant salamander	tailed frog yellow legged frog	0.19	Brown 1988, Neillands 1990
Forty Four Creek	steelhead Pacific giant salamander	cutthroat trout sculpin sp.	0.19	Brown 1988, Neillands 1990, USFS/RNP barrier study notes, DFG 2001 stream surveys
Bond Creek	steelhead cutthroat trout	cutthroat/rainbow trout	0.12	Neillands 1990, Brown 1988
Slide Creek	steelhead		0.12	Brown 1988
Dolason Creek	steelhead		0.12	Brown 1988
Miller Creek	steelhead		0.12	Brown 1988
Redwood Creek	steelhead chinook	coastal cutthroat coho		

Fish Habitat Relationship

Fishery related issues of the lower Redwood Creek mainstem are generally are associated with the highly aggraded and wide condition of the stream channel and suboptimal water temperatures. The lack of channel complexity attributed to excessive amounts of stored sediments is expressed by the lack of deep pools, low pool shelter complexity, increased width to depth ratio, elevated water temperature, high embeddedness values, and reduced summer surface flows. The wide channel also inhibits the riparian canopy to effectively provide shade on the stream. The main channel of Redwood Creek flows through the center of large gravel deposits, which insulate the stream from the benefits of a riparian corridor. These characteristics impair stream habitat conditions and cumulatively, act to limit production of salmonid populations in the lower mainstem of Redwood Creek.

There is a notable difference in fisheries habitat between the lower mainstem Redwood Creek its tributaries. Primarily, the quantity of andromous salmonid habitat is limited by steep gradients of the tributary streams (5.3 miles) compared to the fully accessable reach of mainstem Redwood Creek (19.2 miles). Other differences are related to the smaller size, confined channel, and cooler water temperatures of the tributaries compared to the low gradient, unconfined channel, and warm water temperatures of the lower reach of mainstem Redwood Creek. Coho salmon were recently observed in Tom McDonald Creek, Bridge Creek, and Elam Creek (Dana McCanne unpublished data). Additionally, in Forty-Four Creek, age 1+ and 2+ coast cutthroat were observed. This reflects the higher quality of fish habitat conditions in the tributaries compared to the present state of the mainstem. The impaired condition of the mainstem Redwood Creek limits production of anadromous salmonids in the lower subbasin. Presently, we feel that more production of anadromous salmonids is occurring in the relatively small amount of accessable habitat of the tributaries compared to the larger amount of accessable mainstem Redwood Creek.

Lower Redwood Creek Subbasin Summary

This section presents a summary of the EMDS evaluation results and a comprehensive discussion of the watershed condition for the Lower Redwood Creek subbasin. The subbasin evaluations were determined by calculating a mean, area weighted watershed condition value from all the planning watersheds within the subbasin. The evaluation results of each subbasin are presented in Table 12. The overall condition of the planning watersheds were determined by the results of the following networks:

- Roads overall
- Stream condition
- Stream reach condition
- Upland cover
- (Passage barriers, currently with no data)

Network details are described in Appendix A and maps showing EMDS results are provided in Appendix B.

The overall evaluation rating from the EMDS model for the Lower Redwood Creek subbasin is “somewhat unsuitable”. The somewhat unsuitable rating is determined by the area weighted mean EMDS watershed condition score from McArthur Creek, Bond Creek, Bridge Creek, Coppers Creek, and Devil’s Creek planning watersheds. Table 25 shows the watershed condition summaries for each of the Lower Redwood Creek subbasin planning watersheds.

Table 25: Lower Redwood Creek EMDS Watershed Model Suitability Ratings by Planning Watershed.

Factor//Watershed Unit	Lower Subbasin	Copper Creek	Devil's Creek	Bridge Creek	Bond Creek	McArthur Creek
CALWATER ID		1107.100105	1107.200402	1107.100101	1107.100102	1107.100103
WATERSHED CONDITION	-	-	-	-	-	-
UPLAND CONDITION	-	+	-	- -	-	+
UPLAND COVER	-	+	-	- -	-	-
CANOPY	-	+	-	- -	- -	-
EARLY SERAL	++	++	+++	+++	+++	+++
SLOPE STABILITY	-	+	-	U	+	++
LAND USE	-	+	-	- - -	-	+
ROADS	++	++	+	++	+	+
ROAD USE		U	U	U	U	U
STREAM CROSSINGS	++	+++	+++	+++	+++	++
ROAD DENSITY BY HILLSLOPE POS.	++	+++	++	+++	+++	++
ROAD DENSITY UNSTABLE	+	+++	- - -	++	- - -	- - -
ROAD PROXIMITY	++	+++	+++	+++	+++	+
PASSAGE BARRIERS	U	U	U	U	U	U
STREAM CONDITION	-	-	+	-	-	-
REACH CONDITION	-	-	U	-	-	-
WATER TEMPERATURE	U	U	U	U	U	U
STREAM FLOW	U	U	U	U	U	U
RIPARIAN	-	-	++	+	+	- -

+++ fully suitable
++ moderately suitable
+ somewhat suitable
U Undetermined
- somewhat unsuitable
-- moderately unsuitable
--- fully unsuitable

Roads overall were rated “moderately suitable”. The moderately suitable condition reflects the low number of roads with stream crossings, a relatively low density of roads located on the lower hillslopes (valley bottom), the few miles of roads in close proximity to streams, a low number of road miles existing on “somewhat unstable” slopes in the Copper Creek planning watershed, and the low number of roads located on moderately unstable slopes of the Bridge Creek planning watershed. However, the high road density on unstable portions of McArthur and Bond planning watersheds slightly reduced the overall road condition rating for the lower subbasin.

The positive EMDS evaluation for the roads overall reflects the more than 200 miles of roads decommissioned by RNSP. Efforts by RNSP to reduce sediment delivery to streams by decommissioning or improving many of the roads in this subbasin and recovery of riparian corridors will aid in recovery of fisheries habitat. We recommend to continue to decommission or upgrade roads located on unstable slopes near streams of McArthur and Bond Planning watersheds.

Stream condition in the Lower subbasin was rated “somewhat unsuitable”. The somewhat unsuitable rating for stream condition is largely due to the lack of deep, complex pools observed from the tributaries (Elam, Bridge, and Fourty-four Creeks) and lack of deep, complex pools and lack riparian canopy density affecting the stream observed from the lower mainstem of Redwood Creek. Maps showing EMDS results are presented in Appendix B. Details of the stream reach condition evaluations are presented in Appendix D. We recommend the use of DFG stream inventory surveys to prioritize stream habitat improvement projects in the upper basin (Appendix D).

Water temperature was not included in the EMDS evaluation. Generally water temperature in the Mainstem Redwood Creek is moderately unsuitable (MWAT = 67 ^{o}F) above the confluence with Prairie Creek and fully unsuitable (MWAT = 70 ^{o}F) above Tom McDonald Creek. Bridge Creek was the only tributary located in the lower subbasin monitored for temperture. The average MWAT for bridge Creek from 1996 to 1998 fits the moderately suitable range (MWAT = 60.2 ^{o}F).

The upland condition of the lower subbasin was rated “somewhat unsuitable”. Bridge Creek planning watershed contributed the highest negative influence to the overall rating due to the “fully unsuitable” rating of land use and a moderately unsuitable rating of slope stability, upland cover and canopy. The fully unsuitable rating of land use in Bridge Creek reflects intense timber harvest prior to the RSNP acquired the watershed in 1988. The Copper Creek planning watershed received the most suitable cumulative ratings from the parameters forming the upland condition network of all the planning watersheds in the lower basin. The early seral evaluation indicates that the lower subbasin is generally well stocked with trees greater than ten years old.

In summary, the current condition of the lower mainstem of redwood creek is partially due to legacy effects from past land use practices, major floods events, and natural processes. Fisk et al. (1966) noted that the lower mainstem of Redwood Creek was in a “severely damaged” condition and was “largely unsuitable” as a nursery for young salmon and steelhead following the major floods of 1955, 1964, and 1965. (Fisk et al. 1966). Anecdotal evidence that the lower mainstem was once a productive nursery area is found in a discussion of fish collecting for tagging experiments in the Redwood basin (Hallock et al.1952). Hallock found that in 1951, they could not collect fish for a tagging program from the mainstem Redwood Creek because the pools were too deep to effectively use beach seines to collect fish. The changes to the stream condition between 1951 and 1966 were obviously dramatic and still persist in the form of excessive amounts of stored sediments which adversely affect fish habitat suitability of the mainstem Redwood Creek reach of the lower subbasin.

In addition, changes in tree species composition, seral stage, and canopy structure adjacent to the tributaries and Redwood Creek associated with past timber harvest (prior to RSNP acquired these lands in 1978) also may adversely affect stream habitat conditions. However, it is likely that the riparian corridor is undergoing recovery as trees become re-established and grow along the lower subbasin tributaries. The monitoring of spatial and temporal relationships of the stream condition and fish populations in mainstem and tributaries of the lower subbasin will provide insight into processes of watershed succession.

Subbasin Issues

Working Hypothesis*:* ***Lower Redwood Creek stream habitat conditions are unfavorable for supporting salmonids due to high levels of sediment deposition.***

Supporting Findings:

- The lower reach of Redwood Creek is highly aggraded with sediment.

- Lower Redwood Creek lacks deep, complex pools.
- The stream channel is widened.
- Aggradation and channel widening contribute to a loss of surface stream flow.
- The middle and upper Redwood Creek subbasins have high road densities that are consistent with elevated levels of sediment production.
- Long-term channel surveys show sediment delivered to the stream system from landslides, debris slides, fluvial hillslope erosion, and road related problems, are still stored in the lower reaches of Redwood Creek (Ozaki and Jones 1998, 1999).
- In-channel sediment surveys indicate that fine sediments do not meet TMDL targets.
- Sediment delivery and changes in stream morphology associated with the 1964 flood have had an adverse and long-lasting impact to salmonid habitat in lower Redwood Creek.

Contrary Findings:

- The upper segment of the lower reach, known as Rocky Gap, contains some deep pools.

Recommendations:

- Continue efforts such as road improvements and decommissioning throughout the basin to reduce sediment delivery to Redwood Creek and its tributaries.
- Encourage the use of cable or helicopter yarding on steep and unstable slopes in the middle and upper Redwood subbasins.
- Encourage the monitoring of in-channel sediment and tracking of aggraded reaches in the lower basin.

Working Hypothesis: ***Lower main stem Redwood Creek stream habitat conditions are unfavorable for supporting salmonids due to elevated water temperatures.***

Supporting Findings:

- Lower Redwood Creek stream temperatures exceed a range that is fully supportive of maintaining healthy salmonid populations.
- Historic timber harvest has reduced canopy closure in streamside buffers and likely contributed to elevated stream temperatures.

Contrary Findings:

None noted.

Recommendations:

- Ensure that adequate streamside protection zones are used to reduce solar radiation and moderate air temperatures in order to reduce heat inputs to Redwood Creek and its tributaries.

- Where current canopy is inadequate and site conditions are appropriate, use tree planting and other vegetation management techniques to hasten the development of denser and more extensive riparian canopy.

- Increase continuous temperature monitoring efforts.

Working Hypothesis: ***A lack of instream large woody debris contributes to poor aquatic habitat structure (e.g., lack of large, deep pools).***

Supporting Findings:

- Amounts of in stream LWD in mainstem Redwood Creek and its tributaries on the lower Redwood Creek subbasin are low.

- Historic timber harvest throughout the Redwood Creek watershed frequently removed large conifer vegetation down to the stream bank, severely reducing the available recruitment supply of large woody debris.

- Although stream buffers are regrowing under current land management practices and Forest Practice Rules, buffers with adequate numbers of conifers large enough to function, upon recruitment, as LWD in channel formation processes have not yet been reestablished.

Contrary Findings:

None noted.

Limitations: Formal stream reach surveys were not done for LWD; however observations of crews and findings regarding pool complexity indicate that there is limited instream LWD. Formal survey for LWD loadings could be done to verify these observations.

Recommendations:

- Land managers should use tree planting, thinning from below, and other vegetation management techniques to hasten the development of large riparian conifers.

- Land managers should apply the latest science on placement of large woody debris in stream channels in the Redwood Creek subbasins to improve channel structure and function for salmonids.

Middle Redwood Creek Subbasin

Introduction

Middle Redwood Creek subbasin includes the area above the confluence of Redwood/Devil's Creeks excluding Devil's Creek up to the confluence of Redwood and Lupton Creek. The Middle Redwood Creek subbasin includes the Park Protection Zone, Redwood Valley, and ends at the valley confinement upstream of State Highway 299 crossing. There is a notable difference in fisheries habitat between the mainstem Redwood Creek and the tributaries. The fundamental differences are related to the generally smaller size, higher gradient, and confined channel of the tributaries. The Middle Redwood Creek subbasin supports populations of chinook salmon, steelhead, and coast cutthroat. Coho salmon were noted as present in Karen Creek (Brown 1988), but none were observed during 2001 surveys.

Table 26: Middle Redwood Creek Subbasin Summary.

Middle Redwood Creek Subbasin		
Square Miles	100.14	
Acreage, Total	64,088	
Private Acres	57,843	
Federal Acres	5,838	
State Acres	0	
Principal Communities	Redwood Valley	
Predominant Land Use	Timber Production	
Predominant Vegetation Type	Hardwoods / Douglas-fir Forest	
Miles of Anadromous Stream	44.01	
Low Elevation	325	
High Elevation	4,091	
Fish Species	chinook coho steelhead pacific lamprey	coastal cutthroat trout rainbow trout

Hydrology

See Appendix G. Material from this appendix will be incorporated here in a later draft.

Geology

The complexity of the bedrock structure and mass wasting increases in this part of the watershed, compared with lower. Large "earth flow amphitheaters" are common along the eastern part of the watershed beginning at Coyote Creek. Earth flow amphitheaters (called "composite slide slopes" on the maps) are common in the Incoherent Unit of Coyote Creek (KJfc) and dominate the topography of this part of the basin. They appear to have been formed over many thousands of years by multiple generations of overlapping earth flows. These features typically contain active earth flow complexes.

The Coherent Unit of Lacks Creek (KJfl) underlies steep terrain in the far eastern part of the Middle section (the southwest facing slopes above Lacks Creek). Mass wasting in the Coherent Unit of Lacks Creek (KJfl) appears to occur mostly on steep debris slide slopes, although occasional rotational landslides have also been identified in this Unit.

The typical modes of mass wasting west of the fault are large rotational landslides and debris slides. The rotational landslides are typically subdued and appear to be very old (possibly thousands of years). The Schist of Redwood Creek (KJfr) mid-section near "The Meanders" sports several broad, shallow amphitheaters containing numerous, small watercourses in fan shaped arrays. These amphitheaters may be the eroding floors of fully evacuated ancient landslides.

The Middle portion of Redwood Creek closely follows the Grogan fault zone from Highway 299 to Beaver Creek. The channel widens significantly immediately below the mouth of Minor Creek within this long, relatively straight, fault-bounded reach. In the wider reach, stream bars and terraces are more abundant and voluminous than upstream. Sediment storage predominates here; streamside slides are less frequent. The high amount of stored sediment may be related to a large, long-term input of sediment from the Minor Creek drainage.

The west side of the watershed above this section of the channel sports a series of large, faceted spur-ridges. These are seen as a series of large triangular slope faces extending approximately 3000-4000 feet upslope of the channel. These slope faces may represent remnants of the original topography (ancient canyon wall) or be largely a series of ancient mass wasting features (as mapped). Corresponding facets are not present on the east side of the channel and this may be due to the weak Incoherent Unit of Coyote Creek underlying this section of the drainage.

The main stem narrows and meanders tightly to the west of the Grogan fault zone and within the Redwood Creek schist downstream near Roaring Gulch. The tight meanders are not typical of this relatively steep coastal mountain stream, and appear to be remnants of earlier, gentler (antecedent) valley topography west of the fault (approximately 3-4 million years ago). Inner gorge debris slides are rare along this section of channel indicating that the underlying bedrock is relative stable and resistant. This may represent a change in the Schist of Redwood Creek or a discrete, relatively intact tectonic block. Downstream, beyond the meanders, streamside landslides are once again abundant near the mouths of Panther and Coyote Creeks. Here again, the main stem veers westward into the Redwood Creek schist and away from the zone of the Grogan fault.

The first of a complex series of large cross-faults occurs immediately south of Minor Creek. The sense of throw on these faults is unknown, but they appear to be younger than the Grogan Fault because they are mapped as offsetting it. Rocks associated with the Sandstone and Mélange Unit of Snow Camp Mountain (KJfs) first appear along the extreme west margin of the watershed in this area.

Vegetation

Middle basin vegetation consists of 48,186 acres of forestland along with 11,412 acres of hardwood forests. Although pure conifer stands are found within the subbasin, most of the forested landscape is comprised of mixed conifer hardwood stands. Grassland covers 4,016 acres within the subbasin. In addition small areas, scattered throughout the subbasin are covered with brush. Blueblossom Ceanothus along with coyote brush is found in the dryer south facing sites. Past harvest units within the subbasin appear to be restocked and very productive. The Department of Forestry and Fire Protection’s forest practice program did not indicate any harvest units within the subbasin which do not meet the stocking standards of the Forest Practice Rules.

Land Use

Timber harvesting within the middle subbasin have been on going for many years. Harvest operations were noted on the 1948 air photo series. Ground based yarding methods were the main system utilized in this subbasin. A total of 40,059 acres have been harvested within this subbasin. The highest amount of logging took place during the decade of the 1980s when 50 percent of the area was harvested. Even-aged silviculture is very prominent within the subbasin. Recent operations have centered on the rehabilitation of the understocked areas which now support stands of tanoak. Harvesting of the tanoak and reestablishing conifers is being undertaken land managed by the timber companies.

Table 27: Comparison of the Acres Harvested for the Two Subbasins Upstream of the Park Boundary for the Period of 1950 to 1999.

Years	*Middle Subbasin*	*Upper Subbasin*
1950 - 1959	1,960	1,117
1960 - 1969	1,505	741
1970 - 1979	8,553	1,147
1980 - 1989	24,750	13,693
1990 - 1999	3,291	729

Fluvial Geomorphology

Channels were given preliminary Rosgen classifications according to gross stream gradient at 1:24,000 derived from contour intervals of 40 feet to 80 feet, depending on the quadrangle. The Rosgen classifications are very general and not field checked.

Stream gradients and air-photo evaluation (1:32,000) suggest that the main stem channel varies between Rosgen's B, Fb, C, and F. Smaller tributaries are generally steep A+ channels in their headwaters and more shallow toward their confluence with Redwood Creek.

Water Quality

Table 28: Middle Redwood Creek Subbasin Water Quality Monitoring Summary.

Middle Redwood Creek Subbasin Water Quality Monitoring Summary			
Parameter	**Sampling Period**	**Number of samples**	**Number of sites**
Percent of Fine Material (McNeil cores)	1974-1994	24	3
Temperature	1974, 1996-2001	continuous	15
Water Chemistry	1973-1977	quarterly	5

Table 28 showing a summary of monitoring data compiled for the NCRWQCB 2001 water quality assessment for Redwood Creek. Refer to the attached appendix report for further information and an assessment of the data.

Water Column Chemistry

USGS monitored water quality at four sites in the middle subbasin from 1973 to 1977. Three sites are on mainstem Redwood Creek and two are tributary sites on Highslope and Lacks Creeks. Data for dissolved oxygen ranged from 8-12mg/L (water quality objective <8mg/L), pH ranged from 6.5-8.5 (water quality objective 6.5-8.5), and conductivity ranged from 40-260umhos (water quality objective <220umhos). Data from the middle subbasin are in compliance with Basin Plan water quality objectives and no noticeable trends were observed.

Temperature

The RNSP and landowners closely monitor this area to prevent damage to the parkland downstream. Middle Redwood Creek is the most intensely monitored area of the watershed and temperature data has been collected in this subbasin since 1996. Tributaries are borderline or exceed the "fully suitable" range, while the mainstem approaches the lethal limit of 75F. Salmonid habitat may be threatened by temperature in this subbasin by lack of streamside trees which function to create a cooling microclimate, perhaps a wide channel, and is influenced only slightly by cold water from tributaries to the mainstem.

The east side of the mainstem in this subbasin is bordered by saplings and grasslands offering little cover. Small to medium trees with patches of saplings and grassland border the west side of Redwood Creek in this subbasin. Lack of canopy cover along the mainstem and perhaps a widened channel [more fluvial geomorphology information needed from DMG] may contribute to increased temperatures, especially at Redwood Valley, upstream of Lacks Creek, where maximum MWATs are as high as 72F.

The mainstem is monitored at one site in this subbasin, upstream from Lacks Creek. Temperature monitored on 10 tributaries located on Lupton, Sweathouse, Minor, Moon, Molasses, Mill, Beaver, Lacks, Panther and Coyote Creeks. Monitoring on upper Minor and upper Lack Creeks, two of the major tributaries in the watershed, show cooler (61F) water flowing into mainstem Redwood Creek. Water flowing downstream from the O'Kane station increases from 71 to 72F (maximum MWATs from 1997-2001) at the mainstem Lacks Creek site, both sites being higher than the "fully suitable" range. Tributaries upstream of the mainstem site at Lacks Creek show maximum MWATs of 59-68F water flowing into the middle mainstem. Water from tributaries is up to 12 degrees F cooler, yet the mainstem increases one degree as it flows past those tributaries. Tributaries downstream from the mainstem Lacks Creek site contribute water in the 57-66F range (maximum MWATs from 1974, 1994-2000). Tributaries may not decrease mainstem temperatures much through the middle portion of the basin. Here water quantity may be among the many factors required for maintaining cold water temperatures on the mainstem though comparisons with flow data have not been performed. Climate and canopy cover may also pose threats to temperature regimes in the middle subbasin.

Sediment

The mainstem in the middle subbasin of Redwood Creek was sampled with McNeil core samplers upstream of Panther Creek in 1983 and in 1987 and three tributaries, Panther, Lacks and Molasses Creeks, were sampled with cores at various times between 1974 and 1994. The percent of fine sediment at Panther Creek exceeded the TMDL targets for the <0.85mm and <6.5mm fractions. The Panther Creek area seems to be a problem spot in terms of spawning substrate required for salmonids, recognizing that the data is scattered and scarce. Lacks Creek was sampled in 1987 with results showing compliance with TMDL targets. The abundance of material <6.5mm, as seen in Panther Creek, threatens salmonid fry emergence. Smaller particles can smother salmonid embryos, especially those 6.5mm and less in diameter (Bjornn, et al 1976). It is difficult to comment on the data falling into fractions not incorporated into TMDL targets. However, our attempted comparison of the data shows that there is an abundance of gravel sized material present in this subbasin. See the RWQCB Water Quality appendix for detailed information.

Fish History and Status

The middle Redwood Creek subbasin supports populations of chinook and coho salmon, steelhead and coastal cutthroat trout. There are approximately 24 miles of accessible anadromous fish mainstem habitat available as well as another 19 miles of accessible anadromous fish in 21 tributaries. Most of these tributaries consist of small populations of steelhead. Coho have been found in Coyote, Karen, and Pilchuck Creeks. Chinook have been found in the mainstem as well as Lacks and Minor Creeks. Coastal Cutthroat have been observed in the mainstem as well as Lacks and Panther Creeks. Table 29 presents streams, species present, and the number of stream miles accessible to anadromous salmonids in the middle Redwood Creek subbasin.

Table 29: Streams, Species Present, and Number of Stream Miles Accessible to Anadromous Salmonids in the Middle Redwood Creek Subbasin.

Stream	Species Observed		Stream Reach (mi) Access	References
Lacks Creek	steelhead coastal cutthroat trout pacific lamprey	rainbow trout pacific giant salamanders	4.54	DFG 2001 & 1966 Stream Surveys, Brown 1988, RNP/USFS-RSL revisit of 1981 thesis sites field notes
Minor Creek	steelhead		2.92	DFG 2001 & 1966 Stream Surveys, Brown 1988
Coyote Creek	coho steelhead pacific giant salamander	eastern brook trout pacific lamprey yellow legged frog	2.44	DFG 2001 & 1966 Stream Surveys, Brown 1988, USFS/RNP barrier study notes
Panther Creek	coastal cutthroat trout pacific giant salamander	rainbow trout steelhead	1.74	DFG 2001 Stream Surveys, Brown 1988, RNP/USFS-RSL revisit of 1981 thesis sites field notes
Dolly Varden Creek	trout		1.13	DFG 2001 Stream Surveys
Wiregrass Creek	steelhead		1.12	DFG 2001 Stream Surveys and Brown 1988
Garcia Creek	steelhead		0.25	Brown 1988
Toss Up Creek	steelhead pacific giant salamander	yellow legged frog	0.75	DFG 2001 Stream Surveys, carcass surveys 1998,99, RNP/USFS-RSL revisit of 1981 thesis sites field notes, Brown 1988,
Garrett Creek	steelhead		0.56	DFG 2001 Stream Survey, Brown 1988
Lupton Creek	steelhead		0.56	Brown 1988
Sweathouse Creek	steelhead		0.37	DFG 2001 Stream Surveys, Brown 1988
Mill Creek	steelhead	pacific giant salamanders	0.25	DFG 2001 Stream Surveys, carcass surveys 1998,99, RNP/USFS-RSL revisit of 1981 thesis sites field notes, Brown 1988
Molasses Creek	steelhead		0.25	DFG 2001 Stream Surveys, Brown 1988
Captain Creek	steelhead rainbow trout	pacific giant salamander	0.25	DFG 2001 Stream Survey, Brown 1988
Wiregrass Creek	steelhead		0.25	DFG 2001 Stream Survey, Brown 1988
Beaver Creek	steelhead	pacific giant salamanders	0.19	DFG 2001 Stream Survey, Brown 1988
Karen Creek	coho	steelhead	0.50	Brown 1988

Stream	Species Observed	Stream Reach (mi) Access	References
Pilchuck Creek	steelhead	0.31	DFG 2001 Stream Survey Brown 1988
Cashmere Creek	steelhead	0.25	Brown 1988
Roaring Gulch	steelhead	0.12	Brown 1988
Santa Fe Creek	steelhead	0.06	Brown 1988
Redwood Creek	steelhead chinook salmon coho salmon		

Fish Habitat Relationship

There is a significant difference in the fisheries habitat between mainstem redwood Creek and its tributaries. They should be examined separately as well as uniformly. The fundamental differences are related to the smaller size, higher gradient, confined channel, and cooler water temperatures of the tributaries compared to the low gradient, relatively unconfined channel, and warm water temperatures of the mainstem Redwood Creek.

Comprehensive qualitative population estimates of the middle basin have not been performed. Although a screw trap has been in place for the summers of 2000 and 2001 downstream of Minor Creek, this covers only 10 miles of accessible salmonid habitat in the middle Redwood Creek subbasin, and it does not present fish population estimates pertinent to just this subbasin (see Upper Redwood Creek Subbasin synthesis for summary for specific numbers). It is important to note that no coho were captured in this trap.

DFG electro-fishing surveys were also performed on eleven tributaries in this subbasin for presence/absence of fish species. Steelhead were observed in relatively small population densities. For example Beaver Creek and Wiregrass Creek density estimates were 0.01 and 0.03 steelhead per foot electrofished. Toss up and Coyote Creeks displayed the by far greatest numbers per feet electrofished of 0.6 and 0.4 respectively. These were generally single pass surveys. Coastal cutthroat were found in small abundance only in Panther Creek. No coho were observed in any of the streams electro-fished. Chinook were not observed either, but surveys were performed in mid to late summer, possibly after juvenile chinook would have migrated down into mainstem Redwood Creek. See Appendix D for electro-fishing results.

The lack of any coho being observed through either survey method might be an indication of unsuitable habitat conditions in the mainstem as well as tributaries in the Middle Redwood Creek subbasin. Historical numbers have certainly decreased, particularly in the mainstem. High mainstem water temperatures and lack of complex pools with large woody debris component may be critical factors in absence of coho being observed.

Summer Steelhead have also been also been observed in very few numbers, 2 to 21 from the years of 93 to 98 respectively (RNSP 2000) in mainstem Redwood Creek. The summer steelhead population is thought to be far below historical levels and may no longer have the numbers needed to insure sustaining viable population. No summer steelhead surveys have been conducted since 1998 in the most of the middle redwood Creek subbasin.

We recommend that summer steelhead dives on the middle mainstem of Redwood Creek should be included in annual surveys and to expand monitoring of juvenile fish populations such as current trapping on mainstem Redwood Creek. The presence or absence and population density of coho in this subbasin should be studied more closely in the tributaries as well as mainstem.

Habitat assessments and recommendations for fish habitat improvements for Beaver Creek are presented below. This is an example of what will be presented in the DFG Appendix of the Redwood Creek Watershed Assessment report. Further detail including maps, tables and charts will be available upon request of interested parties and will be available on the KRIS CD.

Beaver Creek

Beaver Creek is a B3 channel type for the first 2,211 feet of stream surveyed and an A2 channel type for the remaining 520 feet. The suitability of B3 channel types for fish habitat improvement structures is as follows: excellent for plunge weirs, boulder clusters and bank placed boulder, single and opposing wing-deflectors, and log cover. Fish habitat improvement structure suitability for A2 channels is as follows: generally not suitable; high energy streams with stable stream banks, and poor gravel retention capabilities.

Flatwater habitat types comprised 43% of the total length of this survey of Beaver Creek, riffles 44%, and pools 11%. The pools are relatively shallow, with only 4 of the 19 (21.1%) pools having a maximum depth greater than 2 feet. In general, pool enhancement projects are considered when primary pools comprise less than 40% of the length of total stream habitat.

<u>RECOMMENDATIONS</u>

1) Beaver Creek should be managed as an anadromous, natural production stream.

2) The limited water temperature data available suggest that maximum temperatures are within the acceptable range for juvenile salmonids. To establish more complete and meaningful temperature regime information, 24-hour monitoring during the July and August temperature extreme period should be performed for 3 to 5 years.

3) Conduct a fish passage assessment of the culvert crossing under Redwood Valley Road. The culvert is located approximately 1,209 feet from the mouth of Beaver Creek. If it is determined that the culvert is blocking fish passage, options should be explored to replace the culvert with one that provides unimpeded fish passage.

4) Increase woody cover in the pools and flatwater habitat units. Most of the existing cover is from boulders. Adding high quality complexity with woody cover is desirable.

5) In the B3 channel type, design and engineer pool enhancement structures to increase the number of pools or deepen existing pools. This must be done where the banks are stable or in conjunction with stream bank armor to prevent erosion.

6) Increase the canopy on Beaver Creek by planting redwood, Douglas fir or other native conifers in the riparian zone. The tributaries to Beaver Creek and the reaches above this survey section should be inventoried and treated as well, since the water flowing here is affected by upstream activities.

7) Suitable size spawning substrate on Beaver Creek is limited to relatively few reaches. Projects should be designed at suitable sites to trap and sort spawning gravel.

Middle Redwood Creek Subbasin Summary

This section presents a summary of the EMDS evaluation results and a comprehensive discussion of the watershed condition for the upper Redwood Creek subbasin. The subbasin evaluations were determined by calculating a mean, area weighted watershed condition value from the entire planning watershed within the subbasin. The evaluation results of each subbasin are presented in Table 12. The overall condition of the planning watersheds were determined by the results of the following networks:

- Roads overall
- Stream condition
- Stream reach condition
- Upland cover
- (Passage barriers, currently with no data)

Network details are described in Appendix A and maps showing EMDS results are provided in Appendix B.

The overall evaluation score from the EMDS model for the Middle Redwood Creek subbasin is rated as “moderately unsuitable” (Table 30). The moderately unsuitable rating is determined by the area weighted mean watershed condition score from Lupton Creek, Minor Creek, Toss-up Creek, Upper Lacks Creek, Lower Lacks Creek, Panther Creek, Coyote Creek, and Roaring Gulch planning watersheds. Table 30 shows the watershed condition summaries for each of the Middle Redwood Creek planning watersheds.

Roads overall were rated “moderately unsuitable”. Roads were consistently problematic in all eight planning watersheds. There is a high number of roads with stream crossings as well as a high number of roads located on unstable slopes in all planning watersheds. There also is high number of roads located on the lower hillslopes (valley bottoms). The Lower Lacks Creek planning watershed is the only planning watershed to have scores in the suitable category concerning road conditions. The rest of the planning watersheds all contained negative ratings in all the categories. This greatly influenced the overall rating of the watershed condition.

We recommend the upgrade or decommission of roads located in all eight planning watersheds in accordance with existing or future road assessment surveys, especially those located on unstable slopes near streams. If new roads need to be constructed, they should not be located near the valley bottom where they may pose a high risk of generating sediment delivery to streams.

The overall stream condition of the Middle Redwood Creek subbasin is rated as “moderately unsuitable” by the EMDS evaluation. Upper and Lower Lacks, Minor, and Toss-up planning watersheds received “fully unsuitable” ratings for the riparian condition component of the stream condition evaluation. Lupton, Coyote, Roaring Gulch, and Panther planning watersheds received a “somewhat unsuitable” rating. Slightly over 60% of the area in the subbasin was harvested in the 1980s (24,750 acres) leaving mostly early seral aged stands. Many of the understocked areas consist of tanoak. Thus, much of the larger coniferous trees, greater than 24” diameter breast height (DBH) have been removed from the subbasin giving poor riparian scores. Coyote Creek and Roaring Gulch were the only planning watersheds to get a positive rating, somewhat suitable for riparian condition.

The stream reach condition is rated “somewhat unsuitable”. The stream reach condition evaluation is based on habitat factors collected from stream surveys and is part of the overall stream condition evaluation(Appendix A). The Middle Redwood Creek subbasin was extensively surveyed from the spring through early fall of 2001 by DFG personnel. Stream inventory surveys were completed on sixteen tributaries, approximately 17 steam miles, in the Middle Redwood Creek subbasin. In addition, approximately 24 miles of mainstem Redwood Creek were also surveyed in this subbasin. Individual stream habitat reports may be reviewed in Appendix D.

Table 30: Middle Redwood Creek Subbasin EMDS Watershed Model Suitability Ratings by Planning Watershed.

Factor//Watershed Unit	Middle Subbasin	Lupton Creek	Minor Creek	Toss-up Creek	Upper Lacks Creek	Lower Lacks Creek	Panther Creek	Coyote Creek	Roaring Gulch
CALWATER ID		1107.200102	1107.200101	1107.200302	1107.200202	1107.100201	1107.200403	1107.200401	1107.100301
WATERSHED CONDITION	- -	- -	- - -	- - -	- - -	- - -	-	-	- -
UPLAND CONDITION	-	-	- -	-	-	-	-	-	-
UPLAND COVER	- -	- - -	- - -	- -	-	- - -	- - -	- -	- - -
CANOPY	- -	- - -	- - -	- -	- -	- - -	- - -	- -	- - -
EARLY SERAL	+	+	- - -	++	+++	+++	+++	-	++
SLOPE STABILITY	-	++	-	-	- -	-	+	+	+
LAND USE	+	+	- - -	+	++	+++	-	+	-
ROADS	- -	- -	- -	- -	- -	-	-	- -	- -
ROAD USE	U	U	U	U	U	U	U	U	U
STREAM CROSSINGS	- -	- -	- -	- -	- - -	- - -	-	-	- - -
ROAD DENSITY BY HILLSLOPE POS.	- -	- - -	- - -	- -	- -	+	-	- -	- - -
ROAD DENSITY UNSTABLE	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
ROAD PROXIMITY	- -	- - -	- - -	- -	- - -	+	-	- - -	- -
PASSAGE BARRIERS	U	U	U	U	U	U	U	U	U
STREAM CONDITION	- -	-	- - -	- - -	- - -	- - -	-	-	-
REACH CONDITION	-	-	-	-	-	-	-	-	-
WATER TEMPERATURE	U	U	U	U	U	U	U	U	U
STREAM FLOW	U	U	U	U	U	U	U	U	U
RIPARIAN	-	-	- - -	- - -	- - -	- - -	-	+	+

+++ fully suitable
++ moderately suitable
+ somewhat suitable
- somewhat unsuitable
- - moderately unsuitable
- - - fully unsuitable
U Undetermined

Both the mainstem and all of the tributaries were given a "somewhat unsuitable" evaluation of the stream reach condition. While the tributaries may have received fully to moderately suitable ratings for canopy density (which is a measure of shade over the thalweg) from the stream surveys, these rating fail to show the age class of the trees and the potential for large woody debris recruitment evaluated in the overall stream condition evaluation. This is an important component lacking in most of the tributaries and mainstem. Mainstem Redwood Creek has a "fully unsuitable" rating for canopy density. Pool quality is another condition that is “somewhat unsuitable” in the mainstem and some tributaries to “fully unsuitable” in other tributaries in the subbasin. This combines pool depth and pool shelter complexity. Unlike the tributaries, mainstem Redwood Creek has “moderately suitable” pool depths based on stream order while the tributaries are generally in the “somewhat unsuitable” to “fully unsuitable” rating. However, pool shelter complexity is “fully unsuitable” for the entire reach of the mainstem and generally “somewhat unsuitable” to “moderately unsuitable” conditions for the tributaries. Embeddedness ratings ranged from “moderately unsuitable” in the mainstem to “fully suitable” in small reaches of Lacks and Minor Creeks. Generally, the tributaries received better evaluation score for embeddedness than the mainstem Redwood Creek.

In brief, mainstem Redwood Creek and its tributaries in the middle Redwood Creek subbasin are hindered by the lack of complex pools including a large woody debris component, riparian cover of adequate size, lack of pool depth in the tributaries, and high embededdness in mainstem. Long term channel surveys show sediment delivered to streams from landslides, debris slides, and fluvial hill slope erosion during the 1964 flood are still stored in the middle reaches of Redwood Creek (Ozaki and Jones 1998 and 1999). We recommend the use of DFG stream inventory surveys to prioritize stream habitat improvement projects in the upper basin (Appendix D).

Water temperature was not evaluated through the EMDS model, but plays a critical role in this portion of the watershed. Middle Redwood Creek is the warmest and most intensely monitored area of the watershed. Mainstem temperatures are monitored at one location just upstream of Lacks Creek and in ten tributaries. Maximum MWAT temperatures have been recorded on mainstem Redwood Creek as high as 72F (22C). This is in the fully unsuitable range for salmonids. The tributaries, although cooler, do not appear to decrease mainstem water temperatures. These extreme temperatures are very close to the lethal limit of 75F for juvenile salmonids. High temperatures causes stressful conditions for the salmonids, limiting growth and increasing risks of disease, thus decreasing the long-term survival rate.

Upland condition was given a “somewhat unsuitable rating”. All eight planning watersheds had moderately unsuitable to fully unsuitable ratings in upland cover and canopy. This is related to recent timbering issue previously mentioned in the overall stream condition evaluation. The EMDS evaluation of early seral stands have somewhat suitable to fully suitable in six of the eight planning watersheds, indicating since previous timber harvests, the planning watersheds are generally well stocked with trees greater than ten years old. These trees could eventually help reverse the unsuitalbe ratings of upland cover and canopy and thus the upland condition as a whole if they are managed to help improve stream habitat conditions. The exceptions being Minor Creek and Coyote Creek, which have rating of fully unsuitable and somewhat unsuitable, respectively. We feel that maintaining suitable forest stands bordering streams will help reduce water temperatures and add to the overall suitability of fish habitat conditions of the middle Redwood Creek subbasin.

Subbasin Issues

Working Hypothesis: ***Middle Redwood Creek main stem stream habitat conditions are unfavorable for supporting salmonids due to high levels of sediment deposition.***

Supporting Findings:

- The main channel of the Middle Redwood Creek subbasin is highly aggraded with sediment in some areas.

- Middle Redwood Creek has some pools; however deep, complex pools are lacking.

- The stream channel is widened.

- The middle and upper Redwood Creek subbasins have high road densities that are consistent with elevated levels of sediment production.

- Long-term channel surveys show sediment delivered to the stream system from landslides, debris slides, fluvial hillslope erosion, and road related problems, are still stored in the lower reaches of Redwood Creek (Ozaki and Jones 1998, 1999).

- In-channel sediment surveys indicate that fine sediments do not meet TMDL targets.

- Sediment delivery and changes in stream morphology associated with the 1964 flood have had an adverse and long-lasting impact to salmonid habitat in Redwood Creek.

- Mass wasting is high in this subbasin, relative to other parts of the Redwood Creek watershed.

Contrary Findings:

- Some deep pools exist in the main channel of the Middle subbasin.

Recommendations:

- Continue efforts such as road improvements and decommissioning throughout the middle and upper subbasins to reduce sediment delivery to Redwood Creek and its tributaries.

- Encourage the use of cable or helicopter yarding on steep and unstable slopes.

- Encourage the monitoring of in-channel sediment and tracking of channel thalweg and bar movement in the middle basin.

Working Hypothesis: ***Middle Redwood Creek stream habitat conditions are unfavorable for supporting salmonids due to elevated water temperature.***

Supporting Findings:

- Middle Redwood Creek is the warmest part of the watershed; stream temperatures exceed the range that is fully supportive of salmonids; and the mainstem approaches the lethal limit of 75° F at some sites.

- Timber harvest and livestock management have reduced canopy closure along many streams and likely contributed to elevated stream temperatures.

- Portions of Redwood Creek and its tributaries are bordered by prairies that provide no cooling shade canopy; it is reported that some of these areas are the result of intensive grazing by sheep early in the 20th century.

Contrary Findings:

None noted.

Recommendations:

- Ensure that adequate streamside protection zones are used to reduce solar radiation and moderate air temperatures in order to reduce heat inputs to Redwood Creek and its tributaries.

- Where current canopy is inadequate, use tree planting and other vegetation management techniques to hasten the development of denser riparian canopy.

- Increase continuous temperature monitoring efforts.

Working Hypothesis: ***A lack of in stream large woody debris contributes to poor aquatic habitat structure (e.g., lack of large, deep pools).***

Supporting Findings:

- Amounts of instream LWD in mainstem Redwood Creek and its tributaries on the Middle Redwood Creek subbasin are low.

- Historic and recent timber harvest in Middle and Upper Redwood Creek subbasins frequently removed large conifer vegetation down to the stream bank, severely reducing the available recruitment supply of large woody debris.

- Although stream buffers are regrowing under current land management practices and Forest Practice rules, dense buffers of conifers large enough to function, upon recruitment, as LWD in channel formation processes have not yet been reestablished.

Contrary Findings:

None noted.

Limitations: Formal stream reach surveys were not done for LWD; however observations of crews and findings regarding pool complexity indicate that there is limited instream LWD. Formal survey for LWD loadings could be done to verify these observations.

Recommendations:

- Land managers should use tree planting, thinning from below, and other vegetation management techniques to hasten the development of large riparian conifers.

- Land managers should apply the latest science on placement of large woody debris in stream channels in the upper and middle Redwood Creek subbasins to improve channel structure and function for salmonids.

Upper Redwood Creek Subbasin

Introduction

The Upper Redwood Creek subbasin encompasses all the area upstream the confluence of Lupton Creek. This subbasin has the highest relief, greatest proportion of natural prairies and has the greatest percent of private ownership. The Upper Redwood Creek subbasin supports populations of chinook salmon, steelhead, and coastal cutthroat.

Table 31: Upper Redwood Creek Subbasin Summary.

Upper Redwood Creek Subbasin	
Square Miles	67.72
Acreage, Total	43,344
Private Acres	40,640
Federal Acres	2,240
State Acres	0
Principal Communities	
Predominant Land Use	Timber Production
Predominant Vegetation Type	Hardwoods / Douglas-fir Forest
Miles of Anadromous Stream	23.03
Low Elevation	866
High Elevation	5,322
Fish Species	steelhead coastal cutthroat trout chinook salmon Pacific lamprey

Hydrology

See Appendix G. Material from this appendix will be incorporated here in a later draft.

Geology

The lower portion of the watershed starts at Captains Creek. The channel of Captains Creek closely follows a mapped cross-fault on the east side of the drainage. Coherent Unit of Lacks Creek (KJfl) and Incoherent Unit of Coyote Creek (KJfc) rocks are offset along this fault. The cross fault continues into the Schist of Redwood Creek, but does not appear to offset its western contact with the Sandstone and Melange of Snow Camp Mountain (KJfsc).

The upper main stem of Redwood Creek lies within a narrow channel that follows the trace of the Grogan Fault zone. Abundant streamside landslides flank the narrow main stem channel, or inner gorge. These slides appear to have delivered sediment directly into the creek.

The Grogan Fault Zone widens to nearly ¾ of a mile at the Captains Creek cross fault. From this point south 4½ miles, the Redwood Creek channel exhibits a striking series of sharp zigzag bends that appear to be structurally controlled. The dominant orientations appear to be southwest and northwest and nearly orthogonal to one another. These channel sections may follow major fracture sets in the underlying Grogan Fault Zone rocks.

Murphy Meadow is a large, gently east-sloping ridge-top basin straddling the western boundary of the drainage. A fault separating the Sandstone and Mélange Unit of Snow Camp Mountain (KJfs) from the Schist of Redwood Creek (KJfr) bounds the basin on the northwest and the Snow Camp Mountain Lineaments (a parallel pair of prominent aerial photograph lineaments) bound the southwest and northeast sides of the basin.

Given the right-lateral sense of movement on a majority of the faults along this part of North America, this feature could be a fault-bounded pull-apart basin. Figure XX illustrates how a pull part-basin forms. Prior field reconnaissance by CDMG personnel identified numerous ridge-top depressions (sackungen?) and marshy areas along this part of snow Camp Ridge. Local ranchers have modified many of these features for use as stock ponds.

The cross-faulting and aerial photograph lineaments appear to continue south to the head of Redwood Creek where they culminate in the Snow Camp Creek fault zone (separates the Schist of Redwood Creek (KJfr) from the Sandstone and Mélange Unit of Snow Camp Mountain (KJfs) to the south). The Grogan Fault Zone does not appear to be offset by the Snow Camp fault zone and is mapped as continuing southeastward, partially obscured by a ¼ mile wide, 2-mile long earth flow complex. The source of this earth flow is not clear, but it appears to have issued from what is now a deeply eroded, broad amphitheater. The major modes of mass wasting are typically rotational slides, earth flows and debris slides.

The upper main stem of Redwood Creek lies within a narrow channel that follows the zone of the Grogan fault. Abundant streamside landslides flank the narrow main stem channel, or inner gorge. These slides appear to deliver sediment directly into the creek (Madej, 1984).

Vegetation

Forests within this subbasin cover approximately 22,683 acres. Hardwoods cover 14,304 acres and grassland accounts for 3,889 acres. Pine in association with Douglas-fir forma a larger component of the stands in this subbasin. Scattered areas of shrubs also show an increase within this subbasin. Most of this shrub component consists of ceanothus, the result of past disturbance. No significant barren areas are located within this subbasin. The total forest environment of the upper subbasin appears to be in good health and productive.

Land Use

Within the upper basin 17,427 acres have been harvested. The highest amount of logging took place during the decade of the 1980s when 78 percent of the area was harvested. Even-aged silviculture is the primary method utilized within the subbasin. Ground based yarding methods were the main system utilized in this subbasin.

Table 32: Comparison of Acres Harvested for the Two Subbasins Upstream of the Park Boundary for the Period of 1950 to 1999.

Years	*Middle Subbasin*	*Upper Subbasin*
1950 - 1959	1,960	1,117
1960 - 1969	1,505	741
1970 - 1979	8,553	1,147
1980 - 1989	24,750	13,693
1990 - 1999	3,291	729

Fluvial Geomorphology

During the storm and flood of 1964, cut logs that had been left lying on steep inner gorge slopes were washed into the mainstem channel (Kelsey and others, 1981). These logs formed massive jams that stretched across the entire channel and backed up sediment to depths of 27 ft (RNSP, 1999). During 1980, RNSP staff surveyed the upper basin mainstem from Roddiscroft Road to Highway 299. They noted an abundance of rounded boulders of metavolcanic greenstone forming a lag in the channel; probably contributed by streamside landslides. The boulders probably contributed to forming the log jams and damming sediment deposited during the waning stages of the 1964 flood. The numerous log jams were not well anchored into the margins of the channel and became easily dislodged. During ensuing, smaller storms the dammed sediment was washed out from the upper basin and moved downstream into the middle and lower parts of Redwood Creek. A locus of sediment accumulation exists below the Tall Trees Grove in Redwood National and State Parks (RNSP, 1999).

By 1980, parts of the channel were nearly cleared of excess sediment from 1964. Remnants of that sediment remained as high as 20 ft on the margins of the channel. These fill terraces had covered and killed old-growth fir and were covered with alder dating from about 1964 (Kelsey and others, 1981).

DMG reviewed air photos of the upper basin. In the uppermost part of the basin, in the vicinity of Roddiscroft Road, mainstem channel conditions are similar between 1984 and 2000 air photos. However, Snow Camp and Twin Lakes Creeks seem to have worsened by 2000; they have more streamside slides and more sediment clogging stream channels. Redwood Creek above Roddiscroft Road appears to have improved by 2000 and contains fewer active streamside slides, though some features may have been obscured by snow cover in the 2000 photos. North of Roddiscroft Road, there seems to be improvement in the channel between 1978-1980 (Madej, 1984) and 1984/2000. Both of the latter photos years show fewer streamside slides and less active sediment in the channel than the 1980 channel maps (Madej, 1984).

We reviewed the 1965 photos for part of the upper basin so far. Our review shows that in 1965, the mainstem was widened very significantly and choked with active, unvegetated sediment. There was so much sediment that separate stream bars were not discernable. The channel was one long streambar. By 1984, only parts of the mainstem still contain excess active sediment; the channel width is greatly reduced. A few active bars formed and several larger vegetated bars were established by 1984. The work of compilation and interpretation is ongoing for the Redwood Creek watershed.

Tributaries are generally steep-gradient Rosgen A+ channels, whereas the main stem channel in the upper part of Redwood Creek is an A in the headwaters and either Fb or B within the length of the inner gorge.

Water Quality

Table 33: Upper Redwood Creek Subbasin Water Quality Monitoring Summary.

Upper Redwood Creek Subbasin Water Quality Monitoring Summary			
Parameter	**Sampling Period**	**Number of samples**	**Number of sites**
Percent of Fine Material (McNeil cores)	1979-1992	32	1
Temperature	1996-2001	continuous	9
Water Chemistry	1981	7	2
Stream Gage	1954-2001	continuous	1

Table 33 showing a summary of monitoring data compiled for the NCRWQCB 2001 water quality assessment for Redwood Creek. Refer to the attached appendix report for further information and an assessment of the data.

Water Column Chemistry

Water chemistry in the upper basin was sampled from 1973-1975 at the USGS O'Kane gaging station at the Highway 299 bridge at the lower end of the subbasin. Data show that dissolved oxygen ranged from 8-12mg/L (water quality objective <8mg/L), pH data ranged from 7-8.5 (water quality objective 6.5-8.5) and conductance ranged from 50-150umhos (water quality objective <220umhos). This headwaters area provide important information of the base level water quality for the Redwood Creek basin. Impacts to this area may have lasting affects to water quality downstream and throughout the watershed. Although rough terrain and steep channels make sampling difficult, an effort should be made to characterize the water chemical parameters in this area, especially to monitor the potential impacts of land use activities such as herbicide applications. Data from the upper watershed obtained for this assessment show compliance with Basin Plan water quality objectives and no noticeable trends were observed.

Temperature

The mainstem in the upper subbasin has been monitored upstream of Minon Creek and at the O'Kane gaging station upstream of Lupton Creek, 11.5 miles downstream from Minon Creek. Tributaries monitored in the upper subbasin include Pardee, Lake Prairie, Minon and High Prairie Creeks. Mainstem temperatures are coolest in this subbasin possibly due to cold water inputs from tributaries and the presence of large trees bordering a narrow incised channel.

MWATs for the mainstem exceed the "fully suitable" range for salmonid production with maximum MWATs of 65F at Minon Creek and 71F at the O'Kane station. However, tributaries in the upper watershed exhibit maximum MWATs of 54-65F. Grasslands cover much of the ridges in this subbasin of the watershed, but the influence of cold springs might keep temperatures low compared to the rest of the watershed. Although this area is managed by logging activities which threaten canopy cover over the channel, cold water flows from tributaries, and perhaps a cool microclimate created by an incised channel, ensure that mainstem temperatures low in the upper subbasin.

Sediment

Upper Redwood Creek basin is a major contributor of sediment down the mainstem (Madej, 1991). According to Ozaki (1988) the channel in this subbasin has widened from increased sediment inputs caused by landsliding events from the 1964 and subsequent storms. Bedrock is exposed in the channel bottom implying that the extraneous sediment has moved downstream, however resultant damage may still impact the channel and thus, spawning habitat.

The site at Hwy 299 was sampled for percent of fine material using McNeil cores in 1979, 1983 and each year from 1989 to 1992 (Table 33). The fractions recorded do not fall into the TMDL targets as critical to salmonid production. However, it appears that gravel sized materials approach TMDL target values, thus posing a threat spawning habitat in the upper subbasin but recognizing that the available data is scattered and scarce.. The presence of gravel sized material 4mm suggest that fine sediments have moved out of this portion of the watershed. See the RWQCB Water Quality appendix for detailed information.

Fish History and Status

The upper Redwood Creek subbasin supports populations of chinook salmon, steelhead, and coastal cutthroat trout. There are approximately 23 miles of mainstem Redwood Creek and 5 miles of tributaries accessible to anadromous fish in the upper subbasin. Fish access on the mainstem ends at Snow Camp Creek, approximately 63 miles from the river mouth. A 45-foot, impassible cascade exists above this point. Table 34 presents streams, species present, and number of miles in each stream accessible to anadromous salmonids in the lower Redwood Creek subbasin.

All the tributaries of the upper subbasin have anadromous fish access limited to less than one mile. Almost two-thirds of the tributaries have a quarter mile or less of accessible anadromous habitat. However this does necessarily diminish the importance of these tributaries because they generally provide some of the best habitat in the basin. Steelhead have been observed from fourteen tributaries of the upper subbasin. Additionally, coastal cutthroat have been observed in two of these tributaries. The tributaries also provide cooler water to help reduce water temperatures in the mainstem, which have been recorded at the "moderately suitable" range for salmonids

Table 34: Streams, Species Present, and Number of Stream Miles Accessible to Anadromous Salmonids in the Upper Redwood Creek Subbasin.

Stream	Species Observed		Stream Reach (mi) Access	References
Minon Creek	steelhead pacific giant salamander	pacific lamprey	0.50	DFG 2001 & 1966 Stream Surveys, RNP/USFS-RSL revisit of 1981 thesis sites field notes, Brown 1988
Fern Prairie Creek	None		0.16	DFG 2001 Stream Surveys, Brown 1988
Bradford/Up. Panther Creek	steelhead		0.99	Brown 1988
Noisy Creek	steelhead		0.50	Brown 1988
Gunrack Creek	steelhead	coastal cutthroat trout	0.50	Brown 1988
High Prairie Creek	steelhead	coastal cutthroat trout	0.43	Brown 1988
Lake Prairie Creek	steelhead pacific giant salamander	tailed frog	0.31	RNP/USFS-RSL revisit of 1981 thesis sites field notes, Brown 1988
Emmy Lou Creek	steelhead		0.25	Brown 1988
Windy Creek	Steelhead		0.25	Brown 1988
Squirrel Tail Creek	steelhead		0.25	Brown 198
Snowcamp/ Smokehouse Creek	steelhead		0.19	Brown 1988
Pardee Creek	steelhead		0.19	Brown 1988
Simion Creek	steelhead		0.19	Brown 1988
Cur-off Meander Creek	steelhead		0.19	Brown 1988
Jena Creek	steelhead		0.12	Brown 1988
Xmas Prairie Creek	None		0.06	Brown 1988
Redwood Creek	steelhead chinook salmon			

Quantitative estimates of upper basin salmonid populations were not available until a downstream trapping study began in the year 2000 by the Redwood Creek Land Owners Association. The first year of the trapping study monitored downstream movements of fish for a four-month period from April 5 to August 5, 2000. Fish moving downstream were collected with a rotary screw trap located on the mainstem Redwood Creek approximately 4 miles downstream of the confluence of Minor Creek. The study produced population estimates of downstream migrating chinook salmon and estimates of age 1+ and 2+ steelhead captured in the trap. These estimates reflect juvenile chinook and steelhead production from the upper one-third of the Redwood basin (approximately 37 stream miles accessable to anadromous salmonids) which includes the approximately 28 stream miles accessible to anadromous salmonids of the upper subbasin.

In 2000, there was a total of 123,633 juvenile chinook, 12,263 age 1+ steelhead, and 736 age 2+ steelhead trapped. These numbers expanded with trapping efficiency data resulted in a population estimate of 427,542 ± 37,446 juvenile chinook, 68,329 ± 9,273 age 1+ and 4,739 ± 1,070 age 2+ steelhead (Sparkman 2000). In 2001, a total 120,692 chinook and 21 1+ chinook was trapped and the population estimate was 378,000 (Sparkman pers. comm.) No coho were observed from either year (Sparkman pers. comm.). Cutthroat trout were not mentioned in the trapping study report.

Fisheries data collected from trapping studies indicate that chinook salmon are spawning in the upper third of the Redwood Creek basin which is largely composed from the mainstem Redwood Creek of the upper subbasin. It is difficult to translate the trapping results to the numbers of adult chinook that returned to spawn or interpret the successfulness of the incubation to emergence of fry from this data. However, these data do indicate that spawning conditions in portions of the upper third of the basin are in the suitable range for chinook salmon and the watershed is supporting fry as well. The trapping studies also indicate juvenile steelhead are utilizing the upper third of the basin. Perhaps the best interpretation of the steelhead data is in the numbers of age 2+ steelhead that are likely undergoing seaward migrations.

In addition to the presence and successful spawning of chinook and rearing habitat for juvenile steelhead, adult summer steelhead counts have slightly increased in the upper mainstem from 3 adults in 1993 to 10 adults in 1998. However, the summer steelhead population is thought to be far below historical levels and may no longer have the numbers needed to insure sustaining a viable population. No summer steelhead surveys have been conducted since 1998 in the upper subbasin.

We recommend that summer steelhead dives on the upper mainstem of Redwood Creek should be included in annual surveys and to continue monitoring juvenile fish population trends such as current trapping operations on mainstem Redwood Creek.

Fish Habitat Relationship

The main issues affecting fishery resources are the same as for the Middle Redwood Creek subbasin. However, the Upper Redwood Creek subbasin may be the most vulnerable to landslides and soil erosion due to the high amount of marginally stable geology observed in the basin. The upper reach of Redwood Creek has generally recovered form the high influx of sediment delivered from the 1964 flood. However, these sediments have been transported to the lower gradient reaches of Redwood Creek of the Middle and Lower subbasins where the transport process is slowed.

Upper Redwood Creek Subbasin Summary

This section presents a summary of the EMDS evaluation results and a comprehensive discussion of the watershed condition for the upper Redwood Creek subbasin. The subbasin evaluations were determined by calculating a mean, area weighted watershed condition value from all the planning watersheds within the subbasin. The evaluation results of each subbasin are presented in Table 12. The overall condition of the planning watersheds were determined by the results of the following networks:

- Roads overall
- Stream condition
- Stream reach condition
- Upland cover
- (Passage barriers, currently with no data)

Network details are described in Appendix A and maps showing EMDS results are provided in Appendix B.

The overall watershed condition rating from the EMDS model was "moderately unsuitable" for the upper Redwood Creek subbasin. The area weighted mean watershed condition score from Twin Lakes Creek, Bradford Creek, High Prairie Creek, and Cloney Gulch planning watersheds was used to determine the overall evaluation rating. Table 35 shows the watershed condition summaries for each of the planning watersheds of upper Redwood Creek subbasin.

Table 35: Upper Redwood Creek Subbasin EMDS Watershed Model Suitability by Planning Watershed.

Factor//Watershed Unit	Upper Subbasin	Twin Lakes Creek	Bradford Creek	High Prairie Creek	Cloney Gulch	Noisy Creek	Windy Creek
CALWATER ID		1107.300103	1107.300101	1107.300102	1107.300203	1107.300201	1107.300202
WATERSHED CONDITION	- -	- -	- -	- -	- -	- -	- -
UPLAND CONDITION	-	-	-	-	- -	-	-
UPLAND COVER	- - -	- - -	- - -	- - -	- - -	- - -	- - -
CANOPY	- - -	- - -	- - -	- - -	- - -	- - -	- - -
EARLY SERAL	+++	+++	+++	+++	+++	+++	+++
SLOPE STABILITY	+	++	+	+	+	++	++
LAND USE	-	+	+	-	- - -	-	-
ROADS	- -	- -	- -	- -	- -	- -	- -
ROAD USE	U	U	U	U	U	U	U
STREAM CROSSINGS	- -	- - -	- - -	- - -	-	- -	- - -
ROAD DENSITY BY HILLSLOPE POS.	- -	- -	- -	- -	- -	- - -	- - -
ROAD DENSITY UNSTABLE	- - -	- - -	- - -	- - -	- - -	- - -	- - -
ROAD PROXIMITY TO STREAMS	--	- - -	- -	- - -	- -	- - -	- - -
PASSAGE BARRIERS	U	U	U	U	U	U	U
STREAM CONDITION	- -	-	- -	- -	-	- -	- -
REACH CONDITION	-	-	-	-	U	U	-
WATER TEMPERATURE	U	U	U	U	U	U	U
STREAM FLOW	U	U	U	U	U	U	U
RIPARIAN	- -	- -	- -	- -	-	- -	- -

+++ fully suitable
++ moderately suitable
+ somewhat suitable
- somewhat unsuitable
- - moderately unsuitable
- - - fully unsuitable
U Undetermined

The mainstem Redwood Creek reach of the upper subbasin shows recovery from excessive sediment accumulations generated from the 1964 flood. Long-term channel surveys show that up to 30 feet of channel fill was transported from the upper subbasin between 1964 and 1994. However bed levels rose approximately 6 feet after the high amounts of rainfall generated sediment delivery to the stream in 1996 (Ozaki and Jones 1998 and 1999). While the upper reach of Redwood Creek has generally recovered from the high influx of sediment delivered from the 1964 flood, it is still vulnerable to landslides and soil erosion due to the high amount of marginally stable geology observed in the basin.

Roads overall were rated “moderately unsuitable”. The moderately unsuitable condition reflects the high road density existing on unstable slopes, large number of roads with stream crossings, and high miles of roads in close proximity to streams. These conditions pertain to all four planning watersheds within the upper subbasin. This negative rating could reflect the marginally stable geology present throughout this watershed in conjunction with the past and present land use. The poor rating of the roads could be a prominent factor in sediment input into the upper watershed.

We recommend decommissioning or upgrading roads located within all four planning watersheds in accordance with existing or future road assessment surveys, especially those located on unstable slopes near streams. If new roads need to be constructed, they should not be located near the valley bottom where they may pose a high risk of generating sediment delivery to streams.

Stream condition was rated “moderately unsuitable”. The moderately unsuitable rating for stream condition is largely due to low percent of stream bordered by forests stands greater than 24” diameter breast height (DBH).

Results form the stream reach condition EMDS model are only available for a small reach of the upper mainstem Redwood Creek and the stream reach accessible to anadromous fish of Minon Creek. The overall reach condition for both reaches was rated “somewhat unsuitable” for anadromous salmonid production. The stream reach condition evaluation is based on habitat factors collected from stream surveys and is part of the overall stream condition evaluation (Appendix A). The somewhat unsuitable condition was mostly due to the lack of deep and complex pools. Maps showing EMDS results are presented in Appendix B. Details of the stream reach condition evaluations are presented in Appendix D. We recommend the use of DFG stream inventory surveys to prioritize stream habitat improvement projects in the upper basin (Appendix D).

Water temperature was not included in the EMDS evaluation. Generally water temperature in the mainstem is somewhat unsuitable. Maximum MWATs of 65F (18C) have been recorded at Minon and 71F (22C) at the O’Kane station respectively. Generally, the further downstream in the mainstem the higher the water temperatures become in the upper subbasin. Water temperatures in most of the tributaries seem to be moderately suitable range.

The upland condition of the lower subbasin was rated “somewhat unsuitable”. All four planning watersheds had fully unsuitable ratings in upland cover and canopy. This, in part, is due to the grasslands, which cover much of the ridges in this section of the watershed. In addition, 78 percent of the area was harvested during the decade of the 1980s. The EMDS evaluation of early seral stands had “fully suitable” ratings in all four watersheds, indicating since previous timber harvests, the planning watersheds are generally well stocked with trees greater than ten years old. These trees could eventually help reverse the negative ratings of upland cover and canopy and thus the upland condition as a whole if they are managed to help improve stream habitat conditions. We feel that maintaining suitable forest stands bordering streams will help reduce water temperatures and add to the overall suitability of fish habitat conditions of the Upper Redwood Creek subbasin .

Although the upper Redwood Creek scored as a “moderately unsuitable” rating by the EMDS model, there have been numbers of chinook salmon and winter steelhead recorded from trapping efforts in the middle subbasin in that likely include fish spawned and reared in the upper subbasin.

Subbasin Issues

Working Hypothesis: ***Upper Redwood Creek stream habitat conditions are favorable for supporting salmonids due to recovery from past channel aggradation.***

Supporting Findings:

- Recent outmigrant studies of salmonids have indicated that chinook salmon are reproducing in the upper Redwood Creek.
- The steeper gradient of upper Redwood subbasin stream channels means that these reaches are more likely to transport than to accumulate sediment.

Contrary Findings:

- Instream sediment sampling at Highway 299 indicates that the percent of fine materials does not meet TMDL targets, which may indicate the presence of less suitable spawning substrate for salmonids.

Recommendations:

- Tailor mitigation efforts to minimize fine sediment inputs to the stream system.

Working Hypothesis: ***The upper Redwood Creek subbasin exports sediments that contribute to aggradation and persistent impairment of salmonid habitat in the lower Redwood and estuary subbasins.***

Supporting Findings:

- The lower reach of Redwood Creek and estuary are highly aggraded with sediment.
- Recent flood events have played an important role in shaping the stream channel and aquatic habitat conditions of the Redwood Creek basin. The flood of 1964 likely has had the most significant and long-lasting adverse impacts to salmonid habitat in Redwood Creek and the entire north coast region. Long term channel surveys show sediment delivered to the stream system from landslides, debris slides, fluvial hill slope erosion, and road-related problems during the 1964 flood are still stored in the middle and lower reaches of Redwood Creek (Ozaki and Jones 1998 and 1999).
- The steeper gradient of upper Redwood subbasin stream channels means that these reaches are more likely to transport than to accumulate sediment.
- Historic land use activities, combined with natural geologic and precipitation regimes have resulted in large quantities of sediment moving into streams in the upper Redwood subbasin.
- The current dense road and actively used network in the upper Redwood subbasin has a high potential for chronic and episodic sediment input to the stream system.

- Abundant landslides flanking the mainstem upper Redwood appear to have delivered sediment directly into the stream.

- Other studies have observed that the upper Redwood subbasin is a major contributor of sediment down the mainstem (Madej 1991).

Contrary Findings:

None noted.

Limitations: Don't have evidence to support via long-term sediment sampling and correlation with runoff.

Recommendations:

- Continue efforts such as road improvements and decommissioning throughout the subbasin to reduce sediment delivery to Redwood Creek and its tributaries.

- Encourage the use of cable or helicopter yarding on steep and unstable slopes in the middle and upper Redwood subbasins.

- Encourage the monitoring of in-channel sediment and tracking of aggraded reaches in the lower subbasins.